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RIVETING CAGES OF THE FORTH BRIDGE.

WE give a perspective view, from *The Engineer*, with a plan and some details of one of these riveting cages. From these it will be seen that attached to the strong ring at the top and bottom of the cage is a vertical girder which carries one part of the riveting apparatus, while the other part of the riveting machine is attached to the similar pivoted girder in the center. Sections of the outer and inner vertical girders are seen in the plan (page 9417), with details for their attachments. In our perspective view the outer riveting girder happens to lie behind two angle-verticals of the cage, but the position of the riveter is shown. The whole cage, including its inner and exterior parts, is raised, from within as the work proceeds.

[THE TEXTILE RECORD.]

STEAM PLANTS FOR TEXTILE MANUFACTORIES.

By CHARLES H. MANNING, Superintendent of the Amoskeag Manufacturing Co.

THE textile manufacturers of the United States have been located chiefly on large water power sites, and in the case of very many of them they have outgrown the water power, and, together with the smaller industries which they attract about them, have been forced to adopt steam as an auxiliary motive power.

At the present time many manufactories are being built up with steam as their entire motive power.

Under these varying circumstances it is difficult to lay down general rules applicable to all cases for the selection and location of their steam plants, but there are many general truths that will apply to all. Each case as it occurs should be referred to a competent engineer in the interest of the manufacturer, and not left to the whim of some engine builder to put in often a needlessly expensive plant to suit his own ideas and pocket.

THE AMOUNT OF POWER WANTED.

The first step should be to make a careful estimate of the exact amount of power that will be required, and in this a due regard should be had to the probable increase of power required, and on the other hand, too liberal allowance for such contingencies should be guarded against, for though in the matter of boiler plant it will not be obligatory to use all the boilers provided, in the matter of the engine it will be necessary to use full cylinder capacity in the case of single cylinder engine, or if a pair is provided, it will be necessary to underload the pair or overload one cylinder, and of the two the latter is the least wasteful of steam.

HIGH AND LOW PRESSURES.

The first requisite of a steam plant is that it shall be thoroughly reliable and to be depended on every day in the year, and this should outweigh great economy of fuel, as the loss entailed by the stoppage of the machinery of a large mill for a few days far surpasses a slight reduction in the pounds of fuel per horse power. The tendency of the day is toward higher pressures, and this in turn necessitates the compound, the triple and even quadruple expansion engine.

Plants are now being built to use one hundred and fifty pounds per square inch boiler pressure with compound engines, also less pressures with quadruple ex-

pansion, but this seems a mistake, as for this number of cylinders it would seem that a pressure of at least two hundred pounds to the square inch would be desirable.

There is no doubt of the economy of high steam, as the great cost of steam is in the change of state from water to steam, the relative costs in heat units of steam of fifty pounds per gauge and one hundred and fifty being (from feed water of 100° Fah.) as 1 is to 1.007. The costs in fuel will differ more, the higher steam

and the several patent tubulous types. With the increased pressures the thickness of shell has increased up to half an inch, which, with the very usual six feet diameter, makes a boiler good for about one hundred and thirty pounds pressure where it is externally fired.

This boiler being heated unequally on its upper and under sides, is subject to unequal strains, and sooner or later shows the effect on the roundabout seams over the fire; and as this defect increases rapidly with the increased thickness of shell, it would seem that a limit

has been reached in this direction. The Scotch boiler used so extensively for many years for marine purposes may be resorted to, but with its internal furnaces it is comparatively an expensive boiler to build and keep in repair.

The brick setting of the common horizontal boiler is a considerable item in first cost, as well as repairs, and the boiler itself is largely hidden from external inspection. With any horizontal tubular boiler, in case of low water, the first tubes to become exposed are the hottest ones, and the lowering of the water level but a few inches may cause serious damage. The floor space occupied by this type of boiler is large compared with that for a vertical boiler of the same power.

In the vertical boiler with a water leg fire box the fire never comes in contact with the shell, so there is no drawback from this source to making the shell thick enough to stand any desired pressure, and, being subject to the same temperature throughout, there are no strains from unequal expansion, and such boilers outlast horizontal tubulars about two to one. The fire box of such boilers should be circular in plan and stayed to the shell as in the locomotive. By using a corrugated furnace, such as is now extensively used in marine boilers, almost unlimited strength may be obtained without stay bolts, and with thinner heating surfaces. The setting of such a boiler consists merely of a brick foundation, serving also as an ash pit, is of small first cost and needs no repairs. This also leaves the boiler free for external inspection at all times by simply removing whatever jacket is used on the boiler.

In case of low water the coolest part of the tubes is first exposed, and the water level may be reduced several feet without damage to the boiler, which makes it a much safer boiler than the horizontal tubular. The floor space is relatively small, but the height is the exact reverse, as sufficient should be allowed to remove a tube if necessary without displacing the boiler. By regulating the water level to suitable height any degree of superheating desired can be obtained, which, where steam is to be carried a long distance, is a matter

of vital importance, and under any circumstances is a valuable feature.

The third type of boiler or tubulous boiler are many of them patented articles, and it is no part of this paper to discuss the relative value of different patents. Their chief recommendation is their subdivision into small integral parts, by which means they can be constructed to withstand great pressure with great safety combined with fair economy.

There is no doubt in the writer's mind that the next few years will show a great increase in the popularity of the vertical tubular boiler, which belief is founded not on hearsay evidence, but on personal experience with a battery of five thousand horse power of them.



PIER TUBE RIVETING CAGE—FORTH BRIDGE.

having a higher temperature, which will decrease the efficiency of the boiler. It must be remembered, however, that this increase of efficiency is on a decreasing ratio; that is to say, the gain in efficiency of 100 pounds over 80 pounds is greater than that of 150 pounds compared with 100 pounds.

For these reasons, boilers to carry the highest pressures attainable with the present state of the art of boiler making should be selected.

BOILERS.

The choice of type of boiler will generally be confined to the horizontal tubular, with external furnace, more extensively used than any other at the present time; the vertical tubular, with or without fire box,

THE ENGINE.

Passing next to the engine, there is for moderate powers, say up to six or eight hundred horse power, a variety of kinds to choose from, but any one who has occasion to look for an engine of one thousand horse power and upward, will find his choice very limited. Manufacturers have been very conservative about adopting the compound engine, and in many cases where steam is used at low pressure for other than motive power purposes, this is perfectly justifiable.

This factor is an important one in selecting the type of engine, for if the uses for low steam are sufficient to consume a large part of the exhaust steam, it is best to select a cylinder large enough to do the work against the requisite amount of back pressure, the reasons for which will be given hereafter. If but a small amount of low pressure steam is required for other work, the best scheme is to use a compound engine, and maintain the receiver pressure at the required point to do the work, and use from the receiver for this work.

That high pressure steam is economical we have already shown, and the best method of utilizing that pressure is in the successive expansion in several cylinders: the higher the pressure, the greater the number of cylinders to be used.

The tandem type of compound engines has the great advantage of compactness and small number of parts as compared with the receiver type with two cranks at right angles. A compound engine never should be fitted with an automatic cut-off on the low pressure cylinder, as this cut-off has no effect on the total expansion of the steam, but merely serves to distribute the load between the two cylinders, and this can only be accomplished by occasional manual adjustment. There is one odd feature of this distribution, to wit, the shorter the cut-off on the low pressure cylinder, the greater the portion of work done by this cylinder.

The economy of the multiple expansion engines is due chiefly to the division of the total range of temperature, from that of the initial steam pressure to that of the exhaust from the final cylinder, among two or more cylinders, thus decreasing the range of temperature in each cylinder.

The type being settled, and I take it no one to-day would think of putting in a simple engine of considerable power except where it is to run against back pressure, and then it really corresponds to the high pressure cylinder of the compound; the next point to be considered is the details of the engine.

Special attention should be given to the solidity and rigidity of the framing of the engine, and much progress has been made in this direction in the last few years, and with the higher piston speeds as well as the higher rotation, greater compactness has been made possible. High piston speed carries with it relatively smaller cylinder volume for given power, therefore less cylinder surface to be heated and cooled at each stroke of piston. Eight hundred feet per minute is not uncommon, and is frequently exceeded with good results.

Ample bearing surfaces should be looked for, and in this respect it should be remembered that when the diameter is sufficient to insure rigidity, further increase is useless, and surface must be obtained by length of bearing. Five hundred pounds load per square inch of projected area (length by diameter) of bearing at a speed of sixty turns per minute, and varying inversely with the speed, is pretty safe to insure cool bearings.

PISTON PACKING AND VALVES.

The piston packing should be such that without excessive friction the engine can be run with the back head off without showing steam leaks, and in large engines care must be taken that the piston is deep enough to insure ample support for itself, some builders losing sight of the fact that the weight of piston increases nearly with the square of the diameter, and that therefore the depth of piston should increase rapidly with the diameter to prevent excessive wear. The valves are a vital point of every engine, and each type of valve has its good points and its bad ones. With the high steam pressures now used in marine practice the piston valve has come to the front, as it is the nearest approach to a balanced valve yet put in use, and has few drawbacks for large engines, as when properly packed it is as easy to keep tight as the engine piston, and, being balanced, requires little power to operate it. The Corliss type of valve, which is the most universally used at the present day for mill engines, is partially balanced, but being a rocking surface does not wear true, and soon becomes leaky. The unbalanced flat slide valve takes considerable power to operate it, and with the high pressures now used, is inadmissible in large engines. Probably more thought has been expended and patents obtained on methods of balancing this valve than any other mechanical problem of this century, but the perfect arrangement is still sought after. The effect of port clearance in the compound engine is a matter of less importance than with the simple engine, but should, of course, be weighed as a source of loss. The question of steam jackets for compound engines seems well enough settled in favor of jacketing both cylinders not to need further discussion; but in the case of a simple engine to be run against back pressure, it is not needed, as the heat robbed from the cylinder by re-evaporation during the exhaust stroke passes off to aid in the work done with the exhaust steam.

The independent condenser and air pump, though requiring more power to operate it, is preferable to the attached air pump, as with the former the speed of the pump can be regulated to the varying conditions of power and temperature of injection water. The question of feed water heaters, economizers, feed pumps, and inspirators depends on so many circumstances peculiar to each case, that the length of this article precludes their discussion here.

LOCATION OF THE PLANT.

Having determined on the plant, the location must next be decided, and of course must have been considered somewhat in the selection.

First, no matter how scattered the places where steam is to be used, there should be but one place to make it, and have that convenient to the coal pile, and carry the steam to where it is needed, as it can be done with less cost and more comfort than carting the coal about. If there are several boiler houses, the general expenses

of each will be practically the same as though all the work was done in one house.

The loss from condensation in well protected pipes is much smaller than is generally supposed, being less than half a mill per square foot of surface in twenty-four hours in very cold weather, with coal at about four dollars a ton. In building the boiler house allow plenty of light, so that the place can always be kept clean, and set the boilers out in sight as much as possible, so access may be had to all parts of them. There is no graver mistake, both as to economy and safety, than to stow boilers away in dark, dingy corners.

One of the most economical boiler plants in this country stands on the opposite side of a river (four hundred feet wide) from the mills where the steam is used.

The power should be developed in as few engines as possible, as the cost is much less per unit in large engines than in small ones, and the engines should be placed as close to the work to be done as is convenient, and great care should be exercised to secure a firm and solid foundation to place them on.

Where they are to be run in connection with water wheels, they should be attached as directly as possible to the water wheel shaft, and when run together, the governor of the water wheel must be thrown out of gear and the engine allowed to do the regulating, which is the reason for connecting them as directly as may be. Where possible, it is best to so place the engine that it may "run over," that is, the crank pass the top center as the cross-head moves toward the shaft. By this means the pressure is always on the bottom slide, and an unpleasant slapping at each end of the stroke avoided, which is almost certain to occur where the engine runs under.

That many will differ with the writer on some of the points discussed is not doubted, but if all thought alike, there would be no use in writing.

TESTING A NEW BOILER.

When a plant of boilers has been completed and accepted, the responsibility of the engineer in charge commences, and if the erection and test of the boilers has not been under his direct observation, it is his first duty to make a personal inspection of them, inside and out, to see that all braces, stays, valves, and fittings are what they should be, and that the boilers are thoroughly clean. He should then test them up to at least once and a half the maximum pressure they are to be allowed to carry.

To do this they should be filled with cold water till it overflows at the safety valve, which should then be screwed down. A light wood fire is then to be built in the furnace, and the heat will expand the water and readily give all the pressure required. This subjects the boiler to the test under conditions the nearest possible to those of actual use, and is perfectly safe, for if rupture occurs there is practically no expansive force to do damage, and the water is not hot enough to scald. The mere opening of a gauge cock will relieve the pressure quite rapidly.

When the test is completed, the safety valve is to be regulated by experiment to blow at one or two pounds above the pressure to be carried.

NUMBERING AND RECORDING.

The boilers are then to be numbered and the numbers painted or otherwise distinctly marked on the front of each, and if there are two rows, the odd numbers should be on the right hand side entering from main door, and the even on the opposite side.

A record book should then be prepared, and in the first pages written a full description of the boilers—when, by whom, and of what material made, and tests to which they have been subjected. Any variation of the steam gauges is to be carefully noted.

The following pages of the book will then be ruled for a weekly record in something of this manner:

Boiler Record for the week ending Jan. 18..

Boiler No.	Steam Pressure.		Coal in tons of 2,240 lb.	Fires.	Remarks as to Repairs, Weather, etc.
	No. of Hours Spent.	No. of Hours Baked.			
			Anthracite.	Chestnut No.	
			Bituminous.	Total.	
			Grate Surface in Use.		
			Tubes Swept (Yes or No).		
			Washed (Yes or No).		
			Grates Renewed (Stated in lbs. or bars).		
Totals.					

* Other columns can be added with advantage, giving temperatures of external air, chimney gases, feed water, steam, and chimney vacuum in inches of water, according to facilities for observation.

If the feed water passes through a meter, which is an excellent scheme, the readings of the meter should be entered once a week. If, also, the pay roll and cost of fuel and lighting are entered, there will be a pretty good record of what is being done and the cost of it.

PERSONNEL.

Where there are a large number of boilers, there should be a water tender, who should be held exclusively responsible for the water level in the boilers, and no one else should be allowed to touch a valve or cock about the boilers. He should also act as head fireman, and have complete control, under the engineer, of all that goes on in the boiler house. The firemen are to be carefully selected, for a poor or careless fireman can readily waste several times his wages, so that it pays to hire firemen and not mere coal destroyers. The wages account will vary from twelve to twenty per cent. of the whole fire room expense, the fuel making practically the remaining eighty to eighty-eight per cent., so that it takes a large saving on wages account to offset a small waste of fuel.

A fireman will handle from six to eight tons of coal a day, where it is delivered to him in front of the boiler. And, with bituminous coal, where there is little cleaning of fires to be done, this can be increased considerably without overtaxing the man. He is to be required to keep his ash pits clear of ashes, clearing them at least twice a day, and, where the fires are run all night, twice during the night. If the ash pits are shallow, which is too often the case, they may require to be cleared every two hours. Where coal is delivered on the fire room floor by team, no coal heavers are required; but where it is wheeled from an adjacent coal shed, a good man can handle thirty tons a day on a level wheel of two hundred feet.

FIRES.

Before fires are laid, the boilers must be filled to the proper level, and kindling stuff should never be allowed in the furnace of an empty boiler on any pretext whatever, for reasons too obvious to mention. Where wood is scarce, it may be economized by bedding the back of the furnace first with fine coal, then lay the first stick across the furnace, and the others, resting on this at one end, are kept up from the grate, and free access of air allowed to the wood. In this way a fire may be started in a reasonable time with a very small allowance of wood. The fires should not be hurried, but at least one hour and a half should be allowed for raising steam in tubular boilers, and a longer time in flue boilers.

The coal consumption should be regulated by the heating surface of the boiler, and not, as is more usual, by the grate surface. With natural draught, from one-fourth to three-eighths of a pound of fuel per square foot of heating surface per hour will give good results. The area of the grate should then be regulated by bricking off part of it if necessary, so as to bring the consumption of fuel to not less than eight pounds per square foot of grate per hour. The burning of fuel at a very slow rate with corresponding low furnace temperature is wasteful of fuel, as it often results in the formation of carbonic oxide gas with the resultant evolution of 8,800 thermal units per pound of carbon, instead of the 14,500 due to the conversion to carbonic acid gas. To insure this perfect combustion, there must be a plentiful supply of air, or about twenty-four cubic feet per pound of coal burned, and from three-quarters to seven-eighths of this air should be supplied through the grates, especially so with anthracite coal, which consumes by the incandescence of the surface, whereas bituminous coal is largely converted into gas, and burns in that state, requiring more air above the coal.

For the above reasons, a soft coal fire requires to be ten or twelve inches thick, and should, if a coking coal, be frequently broken up. Whereas an anthracite fire should not exceed six to eight inches (the larger the coal the thicker the fire), and should only be disturbed on top when it becomes necessary to clean the fire.

Where several boilers are set together beside the main flue damper, worked by an automatic pressure regulator, each boiler should have its own damper, to be closed when the furnace door is opened for any purpose, and these dampers are frequently so arranged that the opening of the fire door closes the damper. This serves the double end of preventing a rush of cold air over the heated boiler surfaces, causing sudden contraction, and also prevents the loss of draught to the other boilers.

The firing should be arranged systematically, so that as few fire doors will be opened at the same time as possible, and so that the average condition of the fires may be uniform.

Whenever it becomes necessary to clean an anthracite fire, it should be allowed to burn down pretty thin; then, with all the tools and a supply of coal at hand, the fire should be pushed back from the door with the hoe, then thoroughly broken up from the bars with the slice bar, after which it is sorted either with hoe or devil's claw, the good coal pushed back and clinkers hauled forward till all is sorted; then haul the clinkers out, spread the good fire, and cover very lightly with coal.

To write this down may seem trivial, but the difference between cleaning it well and ill means, at least, the value of a hundred pounds of coal each time. It is no uncommon sight to see a careless fireman, after pushing his fire back, leave the furnace door wide open while he hunts around for the slice bar, and the same process is repeated for each tool. Then, after pulling out half his good coal, he will go leisurely back and forth for fresh coal to a pile ten feet off. This is no fancy picture. It is what goes on every day, and many times a day, in too many fire rooms. Where steam is not used at night, it costs no more for fuel, and is very much better for boilers, to bank the fire than to haul it every night and start afresh in the morning.

FEEDING.

Cold water should never be fed into a boiler, and, if there is no other way of obtaining warm water, an injector can be used for feeding. The feed should be discharged below the water line and as far from the furnace as practicable. The supply should be as uniform as possible. The gauge cocks are to be more depended upon than the glass gauge. Discharging feed water into the steam space is a bad practice, for, though there is no gain or loss of heat, it increases the chances of wet steam.

BLOWING OFF.

Where the feed water is clear and free from lime, very little blowing should be done. Lowering the level an inch with the bottom blow daily will be sufficient. When the feed water carries much oil or vegetable matter with it, the boilers should be fitted with a surface blow-off, and that should be used frequently. Where the water contains considerable lime or silt the bottom blow should be used several times a day, but for a short period only, the additional feed to be supplied after blowing and not before. After hauling fires never blow the water from the boilers till the steam has nearly died away, for, as far as cleaning is concerned, five pounds pressure are as good as fifty, and when blown off under heavy pressure the boiler cools very rapidly. Close all furnace and ash pit doors whenever the boilers are blown out, that they may cool as slowly as possible, and on no account fill up at once with cold water.

Safety valves are to be tested once a week, and it is well to appoint a certain hour, say on Saturday afternoon, so that if anything is found wrong it may be rectified before starting up on Monday.

FUEL.

The fuel that is the most economical in one place may be the most expensive in another. Near the mines a ton of slack may be obtained for one-half the price of a ton of good coal, and, as it will do two-thirds the

work, it is economical. To carry that ton of slack to New England costs as much as to carry the ton of good coal, and though the difference of cost remains the same, the ratio of cost is changed very much, and the cheap fuel has become the more expensive. Each one must settle the question for himself, and find with which, for a given amount of money, he can evaporate the largest weight of water. Where the fine anthracites, known as pea and chestnut, are used, it will be found economical to mix them with from one-fifth to over half their weight of bituminous. These small grades contain of necessity a much larger percentage of slate than the larger sizes, and they tend to pack very closely and make a dull, sluggish fire with low furnace temperature, which the soft coal, by its coking tendency, helps to overcome.

engine shall do the erecting and start the engine, retaining control until such time as the performance is satisfactory to the purchaser. This, however, does not relieve the purchaser from the duty of a close scrutiny and inspection from the time the first brick of the foundation is put in place.

THE FOUNDATION.

A solid and rigid foundation is of the greatest importance, and if ledge or hard pan is not reached, the excavation should be continued to below water mark, and then a timber platform laid, on which should rest a layer of concrete or beton, and the area of these should be about twice the floor space occupied by the engine, and the thickness depending on weight of engine. On this the foundation, preferably of brick, can be laid without fear of its giving, thereby distorting the engine and causing heating of journals and cracking of frames.

If the engine is to transmit its power by means of gearing, the jack shaft bearings should form part of the main foundation and not be separate structures. Every piece of the machine should be closely scrutinized before being placed.

THE CYLINDER.

The cylinder should be carefully wiped out and its entire bore searched for patches, which, to the practiced eye, are readily discoverable and should never be

tained to the position occupied by the other marks when they were obtained, and the engine is absolutely on the dead point. The other dead point can be obtained in like manner, and when once obtained permanent marks are to be made.

Permanent clearance marks should also be made on the slides, and are to be obtained by disconnecting the rod and bringing the piston up against the heads. If the piston rod screws into the cross head, care must be taken to gauge that also, or the clearance mark on slides is of no value. Ample oil grooves in all bearings should be insisted on, and in high speed engines it is better they should be on the pins and bearings than in the boxes, as the centrifugal force will then tend to throw the oil on to the wearing surfaces rather than away from them.

There is no greater mistake than having a crank pin or cross head box fit too far around the circle. One-third of the circumference in each box is ample; and bearing further out toward the edges of the brasses only tends to wedge the pins, and when they begin to warp they nip tighter and tighter.

If the boxes are babbitted, the metal must be poured on an arbor smaller than the journal on which it is to run, and then thoroughly peened with a round faced hammer to stretch it hard and fast into place before it is bored.

The slovenly work of some builders in this particular should never be accepted by any one who hopes for cool journals.

It goes without saying that the lining and balancing must be perfect if high efficiency and comfort are expected in the future.

STARTING UP.

Everything being in place, it is well to let a very little steam through the engine for from thirty-six to forty-eight hours, to bake all the joints and set them well before subjecting them to the strain of full pressure or motion. If the engine is fitted with an independent condenser and air pump, that is the first thing to start and get into running order, which may be done while joints of main engines are baking.

Once the engine is started, it must be run very slowly for an hour or so at a time, and stopped on the slightest indication of warming in any bearing, and the bearing taken to pieces to find what is wrong, for it is much easier to cure by a little medicine than to allow the disease to run its natural course.

No journal is absolutely round, and many resemble the staves of a barrel. In such cases, running slowly with caps off, if the design will permit it, and scouring them down with bath brick and oil, or powdered glass (but never with flour emery) will be the best and quickest thing to do, care being taken to wash out thoroughly with oil afterward. Working along in this way the engine can soon be brought to full speed, at which point it should be run for a full day without stopping before any load is applied to it.

After this is done the cylinder head should be removed and the cylinder examined, the valves at this end disconnected, or ports blocked with soft pine wood, and the engine run a few minutes with head off to test the tightness of the piston packing.

If cylinder, piston and valves are found to be in good order the load may now be applied by degrees, and when the full load is on, and everything works well, such tests as have been agreed on in the contract may be proceeded with.

The most correct basis of the performance of an engine is the cost of the net power of the engine delivered to shafting in pounds of water evaporated in boiler, but to determine this power requires a dynamometrical measurement, which, with large powers, is difficult to obtain, and for general purposes the net indicated power is sufficiently exact. To obtain this, cards must be taken from the engine when unloaded, and the power computed from these subtracted from the power calculated from cards taken when the engine is fully loaded. This difference will be the net indicated power, and will exceed the power delivered to the shafting by the power consumed by the friction of the load on the engine; in other words, by the difference between the loaded and unloaded friction of the engine itself.

Two engines whose indicated power is the same may differ widely in the power delivered, and, of course, the one which delivers the greater percentage of its indicated power is the better engine. This percentage may vary considerably in the same engine under varying conditions of piston packing, adjustment of bearings, and lubrication of moving parts.

Estimating the cost of running an engine in pounds of coal per indicated horse power per hour is a very crude piece of work and often is very misleading, as an engine costing two pounds of coal per indicated horse power may be a better one than one that is costing but one and eight-tenth pounds per hour.

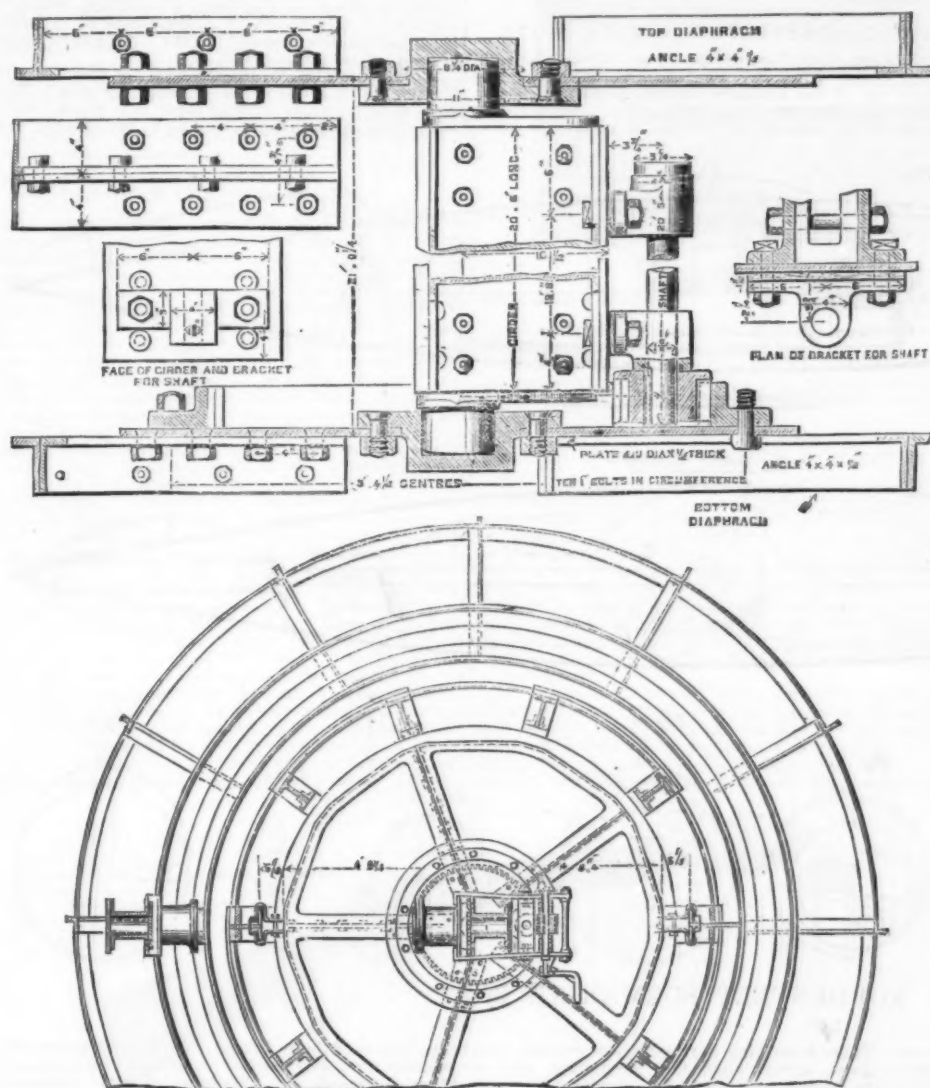
DAILY CARE.

The engine once accepted should be intrusted to a careful, tidy man, for a careless, slovenly man will keep an engine in the same condition, and though he may have the knowledge of a Watt, he is not fit to run and care for an engine.

The larger the engine the more slowly should it be started, and before moving the piston at all the cylinder should be thoroughly warmed up by admitting steam slowly to both ends of the cylinder. Especially is this so in jacketed cylinders, in which it is well to admit steam to jackets at the same time. Many large cylinders, especially in marine engines, have been cracked by unequal expansion caused by the sudden admission of steam to the cylinder when cold.

LUBRICATION.

For the cylinder the oil should be applied through a sight feed cup, so that a uniform supply may be seen going to the cylinder at all times, and nothing has so much reduced the cost of repairs in the steam engine (and boilers, too, for that matter) as the substitution of mineral oils supplied regularly for the old fashioned tallow cup and oil pump, with which the cylinder was dosed once in so often (if not forgotten) and allowed to run dry the remainder of the time. For the cross head, crank pin, and main journals nothing is better than some of the many "greases" now on the market, the point being to get one that, having the right ingredients for lubrication, is just stiff enough to run down the right amount without warming sufficiently to in-



THE RIVETING CAGE—FORTH BRIDGE.—[SEE FIRST PAGE.]

work, it is economical. To carry that ton of slack to New England costs as much as to carry the ton of good coal, and though the difference of cost remains the same, the ratio of cost is changed very much, and the cheap fuel has become the more expensive. Each one must settle the question for himself, and find with which, for a given amount of money, he can evaporate the largest weight of water. Where the fine anthracites, known as pea and chestnut, are used, it will be found economical to mix them with from one-fifth to over half their weight of bituminous. These small grades contain of necessity a much larger percentage of slate than the larger sizes, and they tend to pack very closely and make a dull, sluggish fire with low furnace temperature, which the soft coal, by its coking tendency, helps to overcome.

CLEANING.

Where it is practicable, the tubes are to be swept once a week, and the boilers washed at least once in two weeks. And when the feed water is muddy, as it often is in spring and fall, once a week is better. With horizontal tubular boilers, the man hole plate should be removed and the boiler washed with a hose with a good hydrant pressure on it. The thorough cleaning of boilers inside and out, combined with immediate repair of all defects as soon as discovered, is the key note of "The Management of Boiler Plants."

STARTING NEW ENGINES.

In contracts for steam engines it is almost a universal custom, and a wise one too, that the builder of the

accepted. The bore is to be carefully gauged, and if uniform in size, a variation from the circle may be permitted. This variation often occurs in large cylinders from being bored in a contrary position to that occupied in the engine, it being a common thing to bore a horizontal cylinder in a vertical mill, and *vice versa*.

A patch, or as it is technically known, a "dutchman," in the main journals or pins when well finished is not readily detected by mere inspection; but if the suspected surface is washed with a weak solution of sal ammoniac, a slight rust will be instantly started that develops the grain of the iron and shows the patch at once, if there is any. Such faults as these may run undiscovered for years and then cause very serious break-downs.

For permanent joints no packing, paper, or wires should be allowed, but all such should be made with red lead well stiffened with black oxide of manganese, which, when properly applied, will make a joint as solid almost as the metal itself.

Before setting the valves the dead points should be accurately found, and the best way is after keying up reasonably tight on main bearings and connecting rod ends, turn the engine till the cross head is eight or ten inches from end of stroke; mark the cross head and slide and also mark the fly wheel on periphery from some fixed point. Turn the engine past the center till the cross head and slide marks again coincide, taking care that the lost motion is taken up in the same direction as before. Mark the corresponding point on the periphery of the fly wheel; bisect the distance between these two marks and bring the point so ob-

crease the friction. This will give the best lubrication with the least cost and greatest neatness.

STEAM PRESSURE.

The steam pressure should be kept up to the maximum point at all times except when exhaust steam is being used from the engine for heating or other purposes, when it may become necessary to lower the pressure so as to cause the engine to use more steam and do the work and supply additional exhaust. Also, if the engine is so lightly loaded that cut off takes place at a point that expands the steam to a terminal pressure considerably below the atmospheric line, it will be found economical to reduce the pressure and rate of expansion, and then will ensue a reduction in the amount of initial condensation.

Plainly speaking, expansion can and is often carried to a point producing a loss, and this is more so in un-jacketed cylinders than in those protected with a live steam jacket.

VACUUM.

Where the discharge water from air pumps is made no use of, its temperature should be reduced as low as the load on the pump will allow; but if the boilers are fed from the source the temperature should not be below 110° F., at which point the condenser should maintain a vacuum of about twenty-five inches; and this is more economical than a better vacuum with a lower temperature of feed water. With a jet condenser it is essential that there should be a standing hot well thermometer, as a glance at this in case of loss of vacuum will tell whether a surplus or deficiency of injection water is the cause of the difficulty.

RECORDS.

A general record or log book should be kept, in which should be noted each time the engine is started, the exact moment at which speed was attained, the

up if at all loose, and the neglect of this precaution especially, with the fly wheel or main gear as the case may be, is the cause of many accidents.

The air pump should be frequently inspected, and if the rubber valves are curled on the edges, it is well to turn them over and use them the other side up. Where the pump is vertical, braided hemp is the best packing that can be used, as there is much less friction than with rubber; but with horizontal pumps it is often necessary to use wood for one half the depth of packing so as to support the weight of the piston, filling the remainder of space with hemp.

ENGINES LAID UP.

When engines supplement water powers, there are generally several months in the year when they are unused. When the use is discontinued the cylinder heads are to be removed and kept off, the cylinder being well oiled or covered with black lead and tallow. Any stuffing boxes that are filled with fibrous packing should be unpacked, otherwise the rods are apt to become pitted. All moving parts thoroughly oiled, and pins and journals well protected from dust. At least once a week the engine is to be moved part of a revolution, and for this purpose a hydraulic jack is the most convenient.

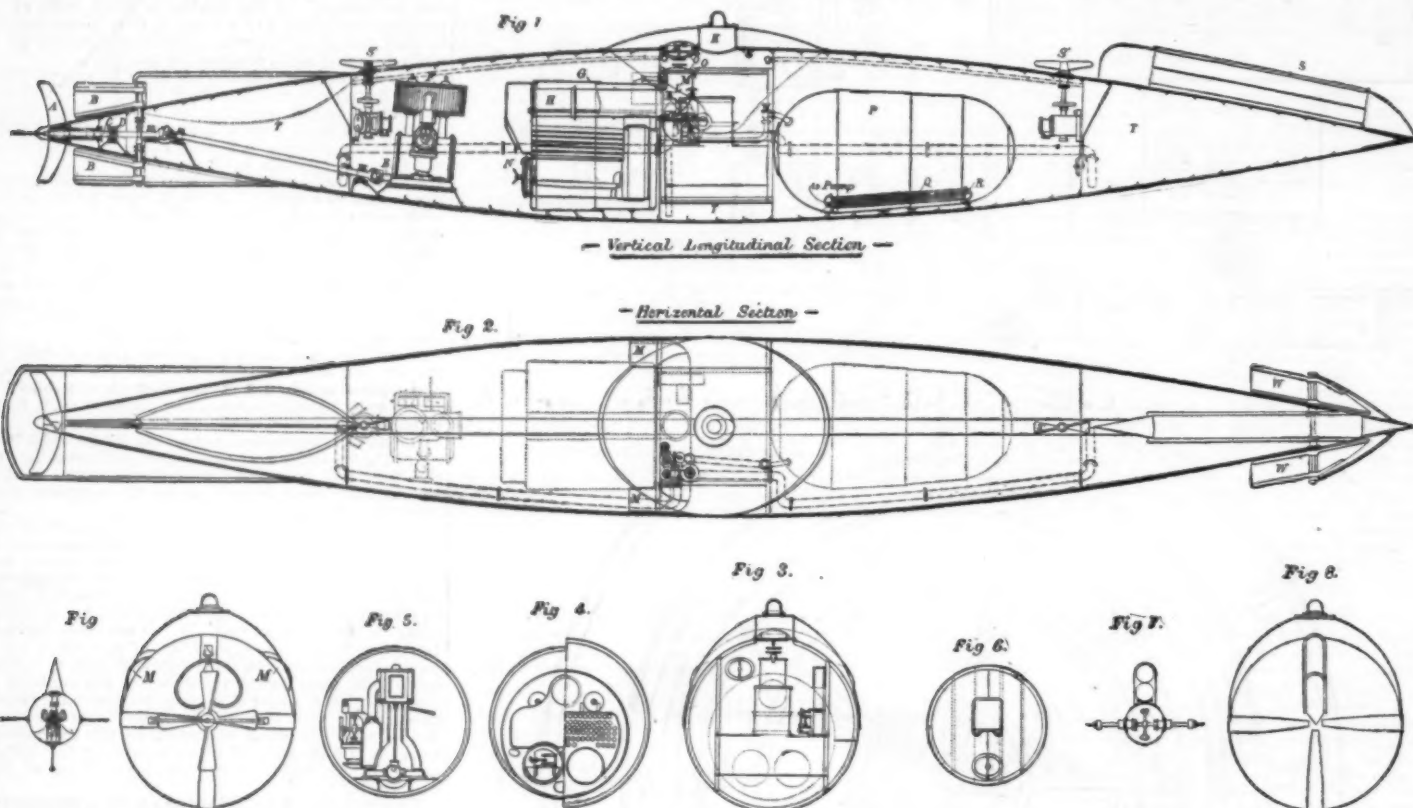
In such articles as comprise this series there are of necessity more things left unsaid than are said, but if such hints as have been given are of interest or service to any of the readers, the chief object in writing them will be gained.

THE NORDENFELT SUBMARINE BOATS.

THEIR principal dimensions are as follows: Length, 100 ft.; beam, 12 ft.; and displacement, 100 tons. The engines are of the ordinary surface condensing compound type, with two cylinders, and are estimated to indicate, at a pressure of 100 lb. of steam, 250 horse

power. The propeller, A, is placed abaft the rudder, B, and it will be noticed that although the shaft is central, working on the thrust block, D, the coupling connecting the crank shaft of the engine, E, is placed low down in the boat. It is this feature in the arrangement which admits of the use of a marine engine of ordinary type. The engines which operate the vertically acting screws are of the three cylinder type. This is in order that there may be no dead center, as it is highly important that they should start the moment steam is turned on. The steam for these engines passes through a valve of peculiar construction, which is worked by the captain of the boat. By its use he is enabled to vary the speed of the propellers and to stop them, both together or separately, at will, and thus to arrange the depth at which his craft is to operate. As seen in the engraving, these propellers in the Turkish boats are placed in the fore and aft line. This is one of Mr. Nordenfelt's recent improvements, these screws in their predecessor having been fitted in side sponsons. In the trials that have so far taken place at Constantinople, this alteration has been found to answer very well. Notwithstanding their slight immersion at the commencement of a descent, no jet of water is thrown up, as might have been expected, a bubbling at the surface being the only indication that the screws are in motion. This new arrangement, it may be added, materially assists in preserving the horizontal position of the boat, a condition which Mr. Nordenfelt has found, by a long course of experience, to be essentially necessary to the safe maneuvering of any sort of submarine craft.

The bow fins, W W, upon which the maintenance of the horizontal position also depends, are seen in Fig. 2. By a very ingenious arrangement of a plumb weight, with other mechanism extending to the conning tower,



THE NORDENFELT SUBMARINE BOAT.

reading of the revolution counter and the same at the instant of shutting down. And from this can be obtained the exact average of speed for the run, which, of course, should be the same from day to day.

Also should be noted the average steam pressure and vacuum for the day, the temperatures of engine room, injection and discharge water. The daily observation and recording of these items may attract attention to some derangement that otherwise might continue for some time before discovery.

Pasted into this same record should be indicator diagrams worked up for each cylinder, and care should be taken that they represent, as nearly as possible, the average performance for the day. If the engine is running in conjunction with one or more water wheels, the fact should be stated, and the amount of gate open on each such water wheel should be carefully noted, not the average for the day, but the exact amount at time of taking cards.

If the engine is of the receiver compound type, it is well to take an occasional card from the receiver. Indicator diagrams taken from the cylinders with the paper barrel receiving its motion from the valve motions are of much interest, showing, as they do, the times of opening and closing of the valve in comparison with its stroke. Full notes should be kept in this book of all repairs and alterations made, and at least once a week the kind and amount of lubricants used should be entered.

INSPECTIONS.

At least as often as once a month the cylinder heads should be removed and the packing tested as well as the cylinder looked after. About every three months the crank pin boxes should be disconnected and the oil grooves cleaned out and deepened if they so require, and about once in six months it is well to treat the cross head and main journal in the same way.

The holding down bolts and fly wheel bolts should be gone over frequently with a wrench to tighten them

power. There is nothing particularly to remark about these engines, except that the circulating and air pumps are worked by a separate cylinder. The main engine is thus left free to work or not, while vacuum is always maintained to assist the various other engines with which the boat is fitted. It may, however, be noticed that all the engines in the boat are specially designed as regards the valve arrangements, etc., that the utmost use may be made of the vacuum. In respect to this, it may be mentioned that experience has shown that during the submarine operations as much power is developed below the atmospheric line as above it. The boiler, marked G in the longitudinal section, is of the ordinary marine return tube type. It has two furnaces, and the heating surface is about 750 square feet. A novel feature about it is, however, that after the products of combustion have passed through the tubes, they again pass through a large pipe marked H, in the steam space of the boiler, before they reach the funnel. The object of this is threefold: first, the economy of heat and fuel; secondly, to enable the funnel to be as near the center of the boat as possible; and thirdly, that the inboard portion of the same might be kept the cooler by thus lengthening the passage to it of the heated air. The hot water cistern is seen at P, and the power to operate all the separate engines during a submarine voyage is the heat as previously mentioned, which is stored up in its contents, as also in those of the boiler. In all there are some 30 tons of water, the vapor of which has a maximum tension of 150 lb. per square inch when the boat is first submerged; and this, with the assistance of the vacuum, is sufficient to drive her from thirty to forty miles without lighting any fire on board or using any air for the generation of heat. The pressure is raised in the hot water cistern as follows: Live steam from the boiler enters at B a series of tubes which have a superficial area in all of some 500 square feet, and after parting with its latent heat to the contents of the cistern, being then in the aqueous form, is taken off by a

small double acting pump and carried back to the boiler. The action of these fins is rendered both automatic and controllable, and perfect command thus insured over the movements of the boats, as far as the vertical plane is concerned. To touch now upon the manner in which the Nordenfelt is operated. It should be understood that the boat has two distinct conditions of existence as a torpedo craft—that of a surface boat and a submarine one. When performing the functions of a surface boat, the air which is sucked into the boat through the conning tower, K, by the fan, L, is forced by the said fan into the engine room. From here, having no other outlet, it passes into the furnaces, and after supporting combustion, reaches the atmosphere by way of the tube, H, as previously described, and the funnel. The connecting link between the inner and outer portions of the funnel, M and M', is not seen, it should be mentioned, in the engraving. In this position, with more or less of her bulk immersed, as may be thought necessary, according to the nature of the service upon which she is engaged, the boat can proceed upon voyages only limited in extent by her coal-carrying capacity. This in the Turkish boat is estimated to suffice for the fuel to drive her 900 knots at a moderate speed. The immersion of the boat in her surface condition is regulated by the admission or otherwise of water into the ballast tanks. Of these there are three, one at each end and a third under the center compartment, T T T, in the engraving. The two first mentioned contain about fifteen tons of water each, and the central one seven, when the boat is at her proper draught for descending. At this draught there is very little of the craft visible beyond the conning tower, and knowing even in which direction to look, it is not an easy matter to make her out at any great distance, the eye being unassisted by the ear, on account of the noiselessness of the engines. All those who have witnessed the running of the boat here have been particularly struck with this feature of her performance, as also the little disturbance at the surface occasioned by the screw.

Before the boat can assume her condition as a submarine craft, it is necessary to hermetically close the furnaces, which is done by the doors marked N, upon which combustion is soon brought to an end. The piece of funnel connecting the boiler with the outboard portion is then removed, and the doors, O and O', placed in position, as shown in the engraving. While these changes are being effected, water is allowed to run into the ballast tanks, to reduce the buoyancy to its proper limit, and this arrived at, nothing remains but to close up the conning tower. The vertically acting screws may then be set in motion to place the boat quite out of sight, or she may proceed with nothing but the glass cupola of the conning tower showing above the surface. As yet, only what may be termed constructors' trials have been made with the boat, although the Turkish naval authorities have always been present.

The boat has run at the surface and made several descents in a very satisfactory manner, and all parts of the machinery having thus been thoroughly tested, she is now being fitted with her torpedo gear in readiness for the official trials. This torpedo gear is of special construction, designed by Mr. Nordenfelt to meet the requirements of the Turkish boats. As the details, however, have not yet been disclosed, it is impossible to say anything on the subject, beyond stating that it is understood to be a very simple and practical piece of mechanism. In the engraving, S indicates the outer case containing the two locomotive torpedoes that form the principal armament of the boat, and there is, of course, a connection between it and the conning tower, by which the captain obtains the necessary command over them. In addition to these two torpedoes, the boat, it should be mentioned, carries for use in her surface condition two Nordenfelt quick-firing machine guns of 1 in. caliber. This greatly increases her defensive power, and renders her a formidable object to attack, even when unprepared to disappear out of sight.—*The Engineer*.

A LINE THROWING GUN.

An invention possessing considerable importance in connection with naval matters has recently been successfully tried in the Tilbury Docks, in the presence of Lieutenant-Colonel Armstrong, R.E., Major Ruck, Captain Drury, R.N., Commander Boxer, R.N., a representative of the Board of Trade, and other gentlemen. The invention is the line-throwing gun of Mr. D. R. Dawson, which is designed to discharge a line, and thus establish communication between any two given points, which may be the shore and a ship, or they may be two vessels or two objects on land. There are two of these guns, a shoulder gun throwing a line 160 yards in length and a $3\frac{1}{2}$ in. brass gun mounted on a carriage, which will project a line more than a quarter of a mile long. In both cases the gun is loaded from the muzzle, the powder charge being placed in an annular space formed by the bore and a central inner tube running from breech to muzzle. The line is wound in the form of a cop, with a hollow extending its whole length. This cop is placed in a metallic case or shell, and the rear end of the line is drawn from the rear of the shell, threaded through the central tube of the gun, and made fast outside it. The forward end of the line is previously made fast to the case, which is then inserted in the gun. Upon the gun being discharged, the case pays out the line as it proceeds forward; and upon its reaching the object aimed at, the line establishes a connection, so that in the case of a ship in distress a rope on board can be made fast to the line and can be hauled ashore or to another vessel. There is no danger of the line being burnt or damaged by the ignited powder, because of the center tube and because a special form of gas check is used. On the

occasion in question, several rounds were fired from the shoulder gun with $1\frac{1}{2}$ drachms of rifle powder, the line being in each case run out to its full length of 160 yards in a direct course and being afterward hauled in. The ship gun was fired twice with $7\frac{1}{2}$ oz. of powder and 400 yards of line, which was also fully run out. In the second round, at the request of those present, Mr. Dawson laid the gun over one of the jetties at the dock entrance, which was exactly 800 ft. from the firing point. The case crossed the jetty in perfect line, falling into the river Thames beyond at the full range of over a quarter of a mile. There was no question of the success of the experiments, which demonstrated the efficiency of the line-throwing guns and their adaptability to the purposes they are designed to serve. One important feature is that whereas rockets carry their own explosive, which sometimes deteriorates and causes the rocket to fail, the line gun is charged with

permits her to extend her radius of action to a great distance from her port of supply. She is, moreover, provided with all the comforts necessary to render life endurable on board during an ocean cruise of several days.

The boat was built after plans by Mr. Lagane, the engineer in chief of the Seyne dockyards. She is 135 ft. in length from stem to stern, 12 $\frac{1}{2}$ ft. in width amidships, and 8 $\frac{1}{2}$ ft. in depth. At a mean draught of 3 ft. she displaces 76 tons at the center, when she has her full load of military apparatus, armament, coal, and crew.

By their fineness, the lines of the keel recall those of torpedo boats. They were studied with the greatest care, with a view of giving the vessel, when completely loaded, a speed of 19 knots. As regards this point, success has crowned the builders' efforts, since, on one of the trials of speed recently made, the mean speed

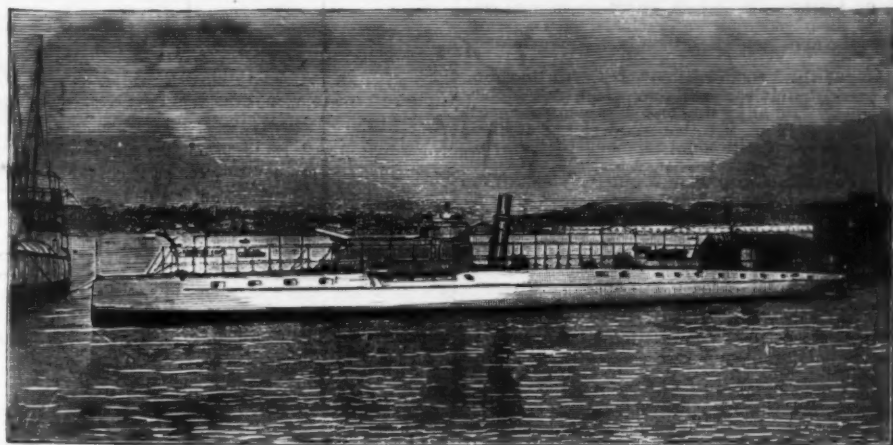


FIG. 1.—THE GUNBOAT GABRIEL CHARMES.

powder at the moment of use, so that the charge can always be fresh and dry. The shoulder gun is also intended to be used on land in cases of fire for establishing communication for saving life. Messrs. McAlister & Co., London, are the agents for this useful invention. —*London Times*.

THE GUNBOAT GABRIEL CHARMES.

THE shipyard at Seyne is now making preparations for the reception and trial of the Gabriel Charmes, in the presence of a special committee appointed for the purpose by the minister of the navy. So we believe it to be a good time to give a few data in regard to this type of war vessel, the trials of which have hitherto been very successful.

The attention of the maritime world has been strongly attracted to this novel engine of war, which, through its power, speed, and invisibility, seems to be called upon to play an important part in the naval contests of the future.

In a few hours, thanks to the powerful engine that actuates her propeller, the boat is capable of reaching any point of the coast whatever that she is to attack, while at the same time escaping the attention of the enemy, owing to the small dimensions of her hull. Let us add, too, that the amount of coal that she can carry

was 19.87 knots, and the maximum reached at a certain moment 19.95 knots. This is a most brilliant result.

The armament of the vessel comprises one 5 inch gun, model of 1881 of the French navy, stationed upon the deck in front of the commander's cabin. This gun is surrounded with a steel plate shield, about five feet in height, designed to protect the gunners against the fire of assailants and against spray in bad weather.

The gun is mounted upon a hydraulic carriage, having a very short recoil, that was specially elaborated for this style of ship by Mr. G. Canet, sub manager of the artillery department of the Forges et Chantiers. One of the peculiarities of this carriage is the automatic re-entrance of the gun in battery as soon as a shot has been fired. The carriage is fixed very firmly to the deck, and the gun therefore cannot be aimed laterally, but only vertically, so as to permit of a positive fire of 30°. Two strong partitions beneath the gun distribute the enormous stresses that occur at the moment of firing, over the hull in general, and limit the powder and projectile magazines, which contain 100 rounds.

Some preliminary experiments in firing have been tried, and have shown that the hull is in nowise strained, even when the firing is done at a positive aim of 30°, with 66 lb. shells and 30 lb. charges of powder. During these experiments, which were extremely satisfactory, the total recoil of the piece did not exceed 18 inches.

The ammunition is served through a special passage back of the gun, communicating directly with the passage between the ammunition magazines under the deck.

We shall now have a few words to say about the internal arrangements, which have been elaborated with



LINE-THROWING GUNS.



FIG. 2.—FRONT VIEW.

a view toward utilizing to the best degree possible all the space disposable.

The crew's quarters are in front of the magazines, beneath the deck, and contain the beds, chests, and hammock hooks and netting necessary for twelve men. Herein are also the galley and the chain wells. Access is had through a special stairway. Beneath the pilot house, which contains the apparatus for transmitting

orders to the engine room, there is a motor with a Duclos governor, and the steward's room and cartridge magazine. Beyond, near the stern, is the boiler room, which also contains a blower and a small donkey engine for feeding. A partition containing a water-tight door separates the evaporating apparatus from the motor that drives the screw. This engine, which is a compound one, with two cylinders, was built at the shops of the Forges et Chantiers, at Marseilles. It is exceedingly light, but extremely strong. It develops nearly 600 h. p. The principal parts are of steel of the best quality. In this compartment we likewise find the condenser with a circulating turbine, and a distilling apparatus (designed to produce seventy-five gallons of fresh water per day), with a filter and a reservoir for water in reserve. At the rear we meet with the officers' quarters. These latter, which are fitted up in varnished mahogany, comprise a saloon with a buffet and sofas covered with garnet morocco, and two rooms with beds, washstands, closets, chart cases, etc., etc., for each of the officers. A water closet, with a pump, completes the arrangement, which is as comfortable as possible.

The sides of these rooms are covered with linoleum, so as to prevent that condensation which takes place on iron plate. Finally, the two last compartments contain a square room, with beds and closets for four masters, and a small sail room.

The deck is free, and it is easy to walk around it. There are no obstructions upon it but the hoods of the ladders that lead below.

These few data will give a sufficient idea of this new craft, which will certainly take part in the great maneuvers that are to take place in May next on the Mediterranean.—*La Nature*.

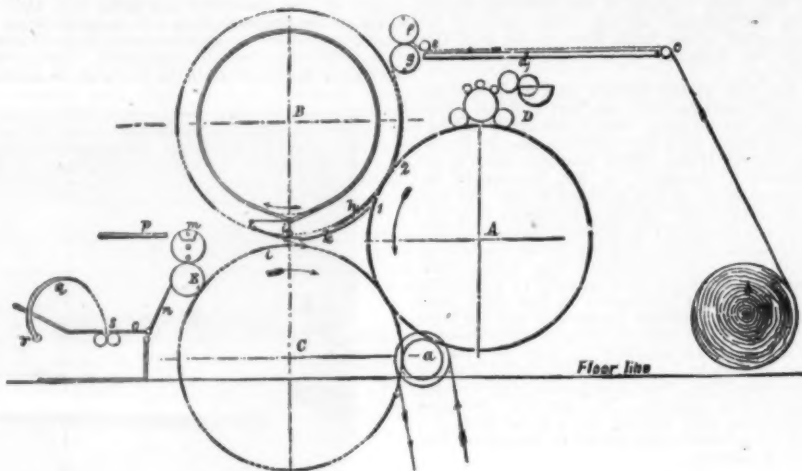
IMPROVED PRINTING PRESS.

In these days of keen competition and gratuitous distribution in enormous quantities of advertising circulars and pamphlets, cheapness of production is a first necessity, both to the printer who secures the contract and the manufacturer who makes his goods known to the public in this manner, and often on a gigantic scale. This method of advertising is the outcome of American rather than of English enterprise, and, therefore, naturally, printing machinery especially adapted for rapid and cheap production of work of sufficiently good quality to suit the purpose is mainly of American design. The Feister Press Company, of Philadelphia, take the lead in this branch of industry, and the Feister book perfecting machine is altogether a very remarkable and efficient piece of mechanism. An outcome of the company named is the Feister Printing Company, which, among other business, is now engaged in working off an enormous edition, numbering many millions, of a thirty-two page pamphlet, forming the advertise-

ment of a popular American patent medicine. Circumstances rendered it advisable to print 8,000,000 of the edition in England, and the company have, accordingly, set up a machine in London at Snow Hill, and started it upon this part of the work, which will find it continuous occupation for two years. Of course, such a machine as this is adapted only for the production of very large editions, but it appears equally adapted to turn out circulars of one, two, or four pages, or to complete pamphlets of eight, sixteen, or thirty-two pages, its maximum capacity being a book of 128 pages small octavo at each revolution.

directions indicated by the arrows on the diagram. It should here be mentioned that all the gearing in the machine is cut, and that all motions are obtained by gearing, so as to give absolutely reliable register. The only belt-driven portion being the inking apparatus, D, which receives its motion off a pulley on the shaft of the cylinder, B. A prominent feature of the machine is also that no tapes are employed, but they are entirely superseded by grippers in every place, and the paper never travels without being under complete and absolute control of the grippers.

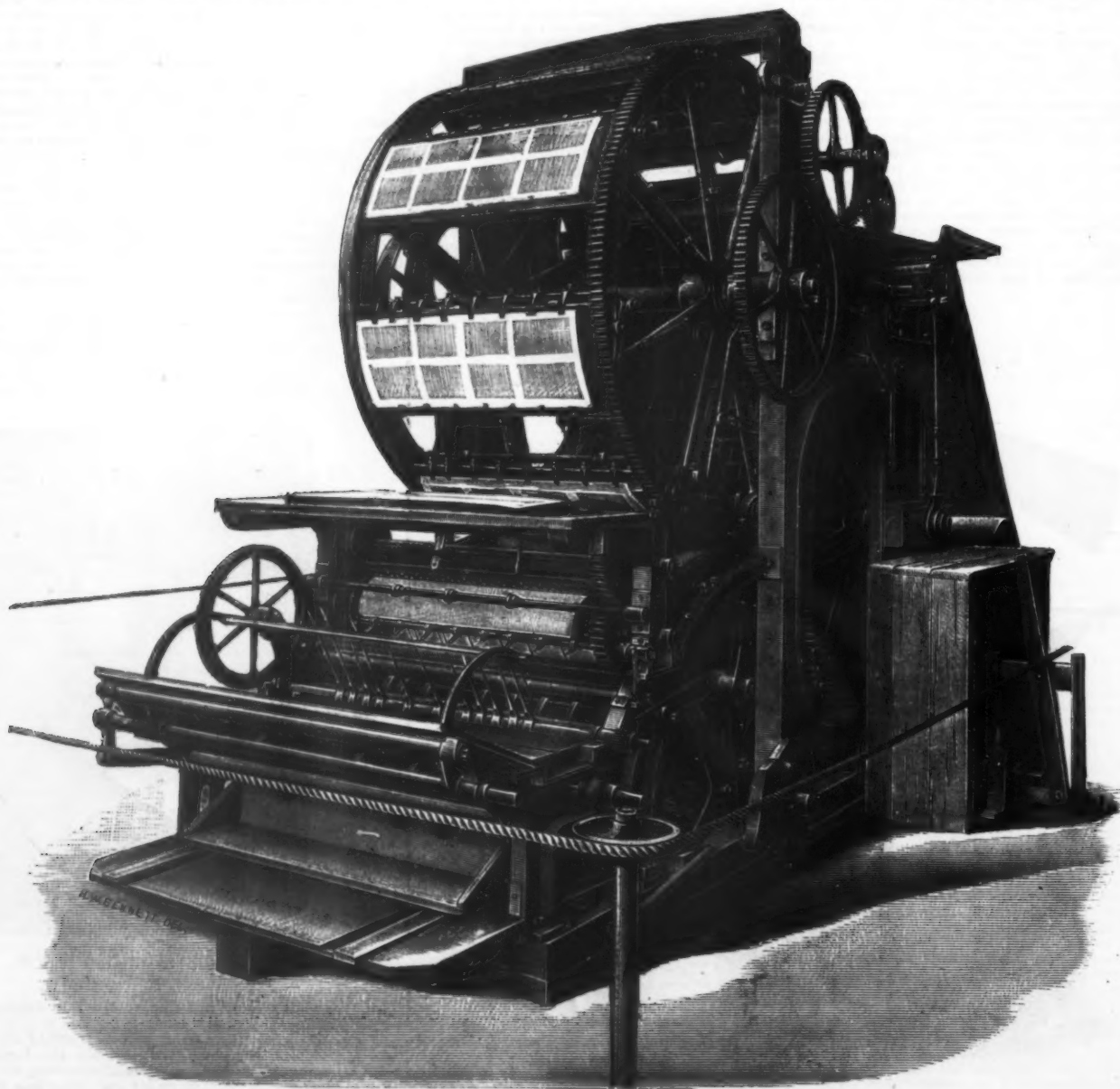
The forms are mounted on the cylinder, A, in a direc-



Having given an idea of the special object for which the Feister printing machine is designed, we may proceed to describe its arrangement, with the aid of the accompanying diagram, that illustrates very clearly its general principles. As will be seen from the illustration, the main features of the machine are the three large cylinders, A, B, and C, each about 6 ft. in diameter and 3 ft. in width. These cylinders are open-framed, and a toothed ring is attached to the side of each. The machine is driven from below by an engine, a belt from which passes over a pulley on the shaft, a. Upon this shaft is a pinion gearing into the toothed ring on the cylinder, C, which, in its turn, drives the cylinder, A, while this latter drives the cylinder, B, rotation being thus given to the three cylinders in the

tion parallel to its axis. They are either stereotypes or electrotypes, sixteen in number, and curved slightly to the same radius as that of the cylinders. These forms are each 3 ft. long and 14 in. wide, and in the case of the special work now being done at Snow Hill, each form comprises eight pages, so that 128 printed pages are turned out at each complete revolution. But, of course, the sizes and arrangement of the pages may be modified in any desired manner. As will be seen in the diagram, the stereotyped forms are mounted close together around the circumference of the cylinder, A, but the surfaces carrying the blankets on cylinders B and C, and on which the paper receives its printed impressions, are spaced somewhat widely apart.

Having described the main features of the machine,



IMPROVED PERFECTING PRINTING PRESS.

we may follow the action of the cylinders through a complete revolution. The paper used is delivered in continuous rolls about 3 ft. wide. Passing from the roll, *b*, it travels over a guide roller, *c*, on the top of the table, *d*, under a second guide roller, *e*, and then between two cylinders, *f* and *g*, the upper one of which is provided with a cutting device, consisting of a saw working with a longitudinal slot in the cylinder, a strip of wood being inserted in a longitudinal groove in the lower cylinder for the saw teeth to bear on when they come into operation upon the paper as it passes between them. Before being cut, however, so much of the paper as is required to form a sheet has been fed out by the cutting rollers on to one of the blankets on the cylinder, *B*, until the outer edge of the paper is seized by the row of grippers placed along the lower edge of the blanket table. As soon as the piece of paper is separated by the cutting mechanism, the grippers hold it in position resting on the blanket, as the impression cylinder, *B*, revolves and brings the sheet into contact with one of the forms on *A*. As indicated on the diagram, the sheet, *h*, would just have received its impression from the form 1. It then continues to revolve until the cylinder brings it into the position shown at *i*, when, by means of a cam mechanism, the blanket table and printed sheet are forced from their normal position, the paper coming into contact with the guard, *k*, until it falls upon the face, *l*, of the cylinder, *C*, when the grippers of *C* seize it, and it commences to revolve in the opposite direction, the grippers of cylinder *B* releasing the other side of the sheet as soon as it is safely deposited reversed upon the impression surface of the lower cylinder. It is then carried forward to receive the second impression, on its unprinted side, from the form 2. We have followed only one sheet from the cutting apparatus, round the cylinder until the operation of printing on both sides is completed. But it is unnecessary to point out that as there are sixteen forms spaced around the type cylinder, the process we have described is repeated eight times with each revolution.

The sheet we have been watching, after receiving its second impression, travels round with the cylinder, *C*, still held by the grippers until it is brought up opposite the collecting cylinder, *E*, upon which it is rolled in such a position that its center longitudinally is brought immediately under a pasting cylinder, *m*, and a streak of paste is deposited along the middle of the sheet. The speed of the collecting drum, *E*, and the gripper action are so regulated that eight sheets are collected one above the other, and pasted down the center, the pressure exerted by the paste duct as it comes in contact with each sheet consolidating the contact between them underneath.

The strip of paste is, of course, also added to the outer sheets when they are taken off the collector and placed on the table, *b*, by the flier, *n*. The board, *p*, contains a pile of wrappers or covers. A boy places one at a time on the table, *o*, the flier puts down upon this wrapper the eight sheets of printed and pasted matter, and the rake-like frame, *q*, hinged at *r*, presses the whole through the slot, *s*, between the two rollers below, which press the nine sheets together into book shape. The result is a long pasted pamphlet, in length equal to the width of the continuous paper fed on to the machine at the other end, and, in the case of the special work under notice, consisting of a row of four thirty-two page pamphlets and a colored wrapper, ready to be cut up under a cutting machine into ordinary single pamphlets. One man attends to the printing machine and a boy to the laying on of wrappers, and these two represent the staff necessary to attend to a machine, which is capable of turning out 2,400 complete pamphlets of thirty-two pages per hour, ready printed, pasted, and placed in wrappers, when running at the comparatively slow speed of 600 revolutions per hour, equivalent to four pamphlets for every revolution of the type cylinder. The work being turned out on this ingenious and very interesting machine is not, from a typographical point of view, high class, but good work depends on a number of conditions besides a good machine, and we may safely say that none of the other conditions were fulfilled. Good type or good electros are, of course, absolutely necessary, and those in use on the machine are decidedly poor, and would, by many a printer, be pronounced bad. The paper is of the kind used for the cheapest newspaper work, and the ink is of low quality, but we can quite understand that with first rate electros, paper, and ink, good work may be produced on machines of the Feister type.

The inking apparatus used does not possess any novel features, but, owing to the distribution of the plates on the circumference of the large type cylinder, two or more color inkers could be used, made to act upon certain plates only, and by this means color work could be produced on a machine of this type.—*Engineering*.

HYDROGRAPHIC SURVEYING.*

By LAURENCE BRADFORD, C.E.

WHEN any hydrographic survey of whatever extent is to be made, the tides must first be taken account of. To the scientist they are an interesting and complicated study, but to the surveyor their use ordinarily is limited to furnishing a water level and datum plane, and it is only in this line that I shall comment on them. For a small work, explaining their main characteristics in different localities, I would refer you to a pamphlet by a member of this society, Prof. Henry Mitchell, issued by the Coast Survey Office some years ago, and prepared principally for the use of naval officers. A datum plane is of necessity the basis of all this work. If the water did not fall or rise, it would be sea level. You know this is often taken now for land surveys, and for that purpose is probably the best of all datum planes, if for no better reason than this interesting fact, that it can be ascertained very nearly at any time by taking the mean between the low and high water of any one tide. The other datum planes cannot be so readily obtained. Mean low water is the one generally adopted for all hydrographic work, though the lowest low water has in times past been very considerably used, principally for the reason that navigators might know that soundings as shown on the charts could always be relied upon as giving at least that amount of water at the place indicated. But while there is some

force to this way of looking at it, it has come to be acknowledged that the best plane for all purposes is mean low water, from which the lowest low water is easily at any time found. To obtain this, the tides should be taken through one lunation, one revolution of the moon, and this is given in fifty-seven low waters by taking the mean of them. It is usual to take the high waters, also, that the usual features may be tabulated, mean rise and fall of tides, establishment of the port, etc. It would give a nearer mean to take the tides for a whole year, but not much. You may ask, How much? To this I can merely state a single experience of my own. While engaged in this work in San Francisco harbor I made a comparison between a mean low water obtained from a lunation and one that had been ascertained by a consecutive record of tides reaching through fifteen years, and the difference was something like thirteen hundredths of a foot, of some value scientifically, no doubt, but hardly to be considered in this work as very important. This record, kept continuously, was obtained by clock work machinery. Section paper unwound from one roll to another at a rate that took in a convenient length of paper for twenty-four hours. A pencil controlled by a simple mechanism attached to a float of the tide gauge gave the rise, fall, and duration, by the wavy line you have seen used to graphically represent the action of the tides. These are well shown in the earlier harbor commissioners' reports of this State, with the effects that obstruction to the free movement of the tides have upon the curves. One curious circumstance they showed me on this record of past tides. Some time before there had been an earthquake of great force on the coast of Japan, the time of its occurrence there had been noted, and the time the tidal wave reached this place was here shown on the tidal curve, in sharp

TIDE GAUGES.

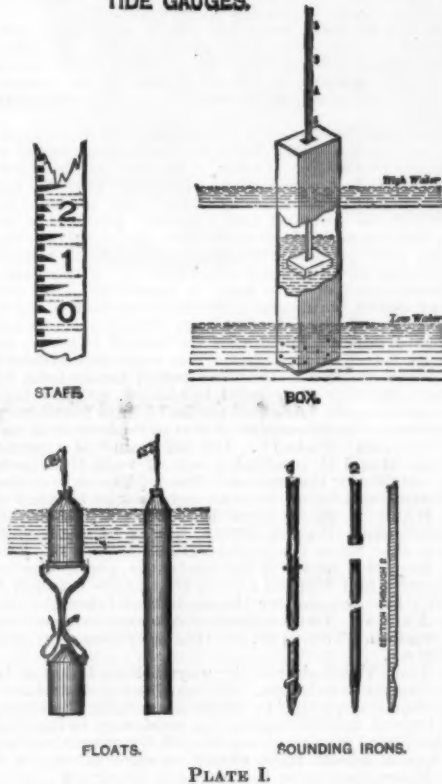


PLATE I.

zigzag lines. I suggested that these might be caused by the quick movement of the waves in stormy weather, but they showed me that the lines made by the sea were not the same.

The gauges I have used have been of only two kinds, the simplest staff and the box gauge, shown in Plate I. I think the staff answers the best. Like a self-reading leveling rod, it can be marked off as the fancy of the observer may dictate. I only care that the parts of the figures be in such relation to the tenths that the height of the tide can be told as far as the numbers can be read with a glass. In the box gauge, the figures necessarily run from up, down. And to work up data from it, the length must be known from the zero of the graduation to the water line of the float. While the hydrographic survey can be made sketchy or elaborate, one of the former kind costs less to make on the water, and one of the latter costs more than the same on the land. And yet the one of the preliminary nature made on the water is more valuable than the same of the topographical kind, for the reason that the element that has furrowed and cut up the surface of the one has tended to even the bottom of the other.

The skeleton outline of hydrographic work is obviously triangulation. The base line being chosen in as commanding a position as possible, the other stations may be cut in from its ends, without the calculation of triangles, or the other points may be occupied and the triangles completed. Points not occupied, it is hardly necessary to say, are fixed by a considerable number of intersections.

These stations, if they are to be used for getting sextant angles, are best defined by the spires of old fashioned meeting houses. They are rather to be preferred to show against the sky to the observer. But as they are generally painted white, it does not make so much difference. The lines of soundings it is now customary to take as evenly as possible, making them cross so as to form regular geometrical figures, when their usefulness is not sacrificed, as they look much better when plotted.

The lines of soundings should frequently intersect, as on their well crossing lies the best proof that the work has been well done. If the sheet of water is

nearly emptied by the tide, the low water channels can be quickly and well defined by zigzagging, as it is called. That is, running over them after the manner of a Virginia fence, when the tide has left the harbor.

The implements I have used for borings are shown on Plate I., made of gas pipe $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches diameter. A craft made for the purpose, with a well in its center, or platform running out from its side, where tackles and purchases can be applied, answers best for these operations. I have never had much difficulty in getting the rod down to any depth required and ascertaining the quality of the material penetrated, but in getting the rod out has been the trouble. When not fitted out as above described, a good way of applying a persuader, when meeting with an obstinate case, is to moor two boats, the sounding iron between them. Then place across the boats a small boat's mast. Fasten to the sounding iron a foot or so below the surface a single or double line, the other end wound around the boat's mast. Use this as a windlass. This power, with the help of the tide, in a bad case, I have always found effectual.

The best method I have followed to take the speed and direction of tidal currents I think to be this: A simple tin can is loaded with shot or stone till the top is just above the water. This is for the surface current. If it is desired to know the mean current, sink a similar can below the floating one connected by a line, or a long single line can be used as shown in Plate I.

Place yourself on the position where you wish to begin. Take the time to seconds and let it go. After it has gone far enough, or changes its course, drop a floating buoy with line and weight attached alongside of it, at the same time taking the time. This buoy can then be located, the float followed up, and the operation repeated.

I will now speak on the location of positions or points, principally the theory and practice of locations by sextant angles, on which I would devote the most of my time.

On this question might be said to hang my main subject and everything pertaining to it, just as in religion we are told on two simple commandments hang all the law and the prophets. If the line of soundings is long, points on its length must frequently be established, otherwise the plotted soundings will not represent the place where they are shown.

A good, perhaps the best, method of doing this, where a suitable range can be had, and the conditions are otherwise favorable, is to cut in the soundings from a point on shore with a transit instrument, placing it where the intersections will be good ones throughout the length of the line. It is well to take them at equal spaces of time apart, for then can be seen how evenly your boat has moved on the course. The recorder of the soundings, having a watch in his hand, gives a signal to the leadman as the second hand approaches the minute. The leadman raises his hand, and the intersection is made. Another method is to have no observer on shore, but to take one angle with a sextant from the boat at the points desired, choosing the stations observed upon in such relation to your line of soundings as to vary rapidly your angle with the moving of the boat. If you are not running a continuous straight line, at the point where the direction changes two angles would have to be taken, requiring two sextants and two observers in the boat. The principles of this method I am going to discuss further on.

Sometimes lines of soundings are run between known positions without being cut in along their length, and the only way taken of adjusting the individual soundings is to check off equal spaces of time, the same as I have described in connection with transit intersections. These are called time soundings, and are based on the assumption that the boat has moved over equal distances in equal times.

THE SEXTANT.

I am going to keep along on the same subject, but make a sort of a side show in speaking of this instrument, which alone is made use of in locating positions by the method I shall describe.

This is the most satisfactory of all surveying instruments, within its limitations, and is indispensable for hydrographic work. It is readily carried in the hand, does not need a stable foundation for the observer, and can be used at a minute's notice, taking angles, vertical, horizontal, or inclined; and reads readily to ten seconds by its large arc. Its main characteristic is, that it takes its angles by a mirror, on the principle that the angle of incidence is equal to the angle of reflection. There are two mirrors, one that takes the angle, and is secured to the arm that has the vernier. The other are fixed, and brings the reflected image to the eye. By this double reflection the arc that the vernier passes over is only one-half the angle really measured. The arc is the sixth of a circle, hence its name sextant; while according to the principle above, it can measure an angle of 120° .

It is a curious fact that this instrument was invented by two men at nearly the same time, unknown to each other. One, the famous Newton; the other, John Hadley, who made it known, and to whom is given the honor of its discovery. It can be put to uses outside of what might be called its legitimate work.

When vessels are on the same course, it can be used on board, either by taking an angle from the mainmast truck to the water line, to tell whether they are approaching or separating, a difficult matter to judge by the eye when in this relation to the distance to be estimated. It is said on board slave ships in old times, when they were pursued, that when the sextant angle began to grow larger, they began sawing through their deck beams. In reconnaissances on horse-back, when it would be inconvenient to dismount, an angle or location can be taken from the saddle. Lieut. George H. Mendell, of the engineer corps of the army, now Colonel, published some years ago an interesting book on this instrument.

Location by sextant angles is the main method in hydrographic work. The intersections that determine the locations are made by the crossing of circles whose circumferences pass through three fixed points, the middle one common to both circles. These fixed points, here called stations, may be in many possible positions relative to each other and to the intersection point, but the relationship determines their worth to a marked degree, many cases being wholly valueless. If the sta-

* Read before the Boston Society of Civil Engineers, December 15, 1886.

tion and intersection point are in the same circumference, there can be no approach to a location, as the angles, without changing, will whirl around the circles, and no good location can be made even near to this circle. It is often given as a rule that the sextant angles should not be less than 30° or more than 120°. I would have them not less than 40° or more than 100°, but angles within these limits may be used and still the location not be a good one, if the crossing of the circles do not make a good intersection; and *vice versa*, the crossing of the circles may make a good intersection and the angles not be within these limits, when the location would be a poor one. I have given four cases in Plates II. and III. that will with modifica-

The stations at equal distances are best; not a measured, but an approximate equality. I have shown in Fig. 2, Plate III., the extreme stations at unequal distances from the central one. The important effect of this is the shortening up of the field of operation.

These remarks can be condensed and substantially expressed by these simple propositions:

1. That the sextant angles be not less than 40° or more than 100°.
2. That the stations be about at equal distances apart.
3. That a point midway on a line connecting the outside stations be not more distant from the central one than it is from the outer stations.
4. That the location or intersection point be not near the circle passing through the stations, nor outside of it.

It is not pretended that these remarks or rules will strictly apply to surveys of all natures and all areas in some instances.

They might well be thought to draw the question a little too fine; but when it comes to reverse the process and find upon the water certain features that have been shown by the plot, or to reproduce many times the same points and define the elevations of submarine rocks or ledges, they will not be found, I think, to have carried the discussion to an unnecessary degree of precision.

To reproduce any point that may be required after a survey has been made is not so easily done as to make the survey in the first place. It is, however, then ascertained how well the stations have been chosen and the work has been done. To reproduce these points requires some mechanical dexterity, gained by practice, learning to direct the movement of the boat that the images of the stations will close in the mirrors of the sextant in a short space of time, as surveying in this line has commonly to be done at smooth and slack water, sometimes after weeks of waiting, so that little time can be spent in fixing a single point.

Two sextants are required, one in each hand, the left hand one set to the angle for B and A; the other with the angle for A and C. When the point is found it is usually marked by a floating buoy, if for temporary use. If needed permanently, by a pile or anything desired.

In plotting these angles, I have followed three ways. The best, undoubtedly, is by an instrument called a three-arm protractor. It is a graduated circle, much like a transit instrument plate, commonly of six inches diameter, its center so constructed that the central point may be observed and marked. About this revolve the two movable arms on each side of a fixed one, at the zero of the graduation. These arms have lengthening parts, screwed on or removed at pleasure. An instrument of this kind is expensive, and not always easily obtainable. Another method is by a graduated circle of a foot or so in diameter, engraved on tracing paper. The angles are laid off in pencil on this and moved to the spot. The most inconvenient part of this method is, that the pencil marks must be rubbed out after each point is plotted, or they will confuse the work. Another method I have found very convenient, where much work was to be done from one set of stations. Plate IV. Lay off from the extreme stations, B and C, graduated arcs of radii that seem most suitable for the matter in hand. The zero of the graduation will be on lines at right angles to BA, CA from B and C. Bisection these lines BA, CA and lay off perpendicular. Having sextant angles to plot lay off the one that takes the stations B and A from B. And take the point where it intersects the perpendicular for a center and describe a circle that passes through A and B. Do the same for the angle that takes the stations A and C. The intersection of these circles will be the location. The proof of this operation you will readily see.

On Plate V. are shown the ways I have followed in surveying rocks or ledges. Fixing a boat at A, and running soundings, either in circles at regular distances, or in lines at defined angles. A good way to locate a point without survey of any kind is by ranges, taking two sets at about right angles to each other, for, if well chosen, they have the precision of sextant angles. The difficulty is, in not being near enough to the shore to obtain good objects, principally to get the first one sufficiently near.

The advantages of this method of location were first brought to my notice, as well as a way of clearing out channels, since common enough, but then at least new to me, on the James River, just after the capture of Richmond. I was then attached as second in command to a dispatch boat that plied between City Point and Fortress Monroe, and the first vessel to enter Richmond as the time of its capture. The river was then found to be full of obstructions, and it was judged of torpedoes, as they were seen in heaps along the shore between Bermuda Hundreds and the entrance to the city. At once operations were entered upon for clearing the channel. A military engineer was assigned this duty, and our vessel was placed at his disposal. He had tin cans made, holding from three to ten gallons. These were filled with coarse powder found in the abandoned magazines of the rebel works along the river.

The engineer officer would feel over the channel at the shoal places, with a sounding iron, judge what the obstructions were and the best place to sink the cans, locate himself by two sets of ranges. When he found the best place, a can was then sunk at this place and exploded by a galvanic battery, when the obstructions, mostly sunken vessels, were thrown out.

The Fish Commissioners in their late report give a method of making their location at sea, making no pretensions to novelty. In a telescope having microscopic lines, they take the spans of natural objects like mountains, but principally lighthouses, all the altitudes of which are given in the Lighthouse Department manuals. They take at the same time a compass bearing. I have at times followed a method of this kind for the determining of points of secondary importance, usually short lines, with the needle of a transit instrument taking three compass bearings on three of my fixed stations. They can be plotted the same as if taken by distant angles, or they can be plotted as compass courses.

You may ask, "How is a sunken rock found, as you do not pretend to go over the whole bottom when making a survey?" To this I would answer, that they are often found as the Irish pilot found one. To the question if he knew the harbor, he replied, "Yes; and every rock in it;" later, when the ship brought up all

standing, "and this is one of them." The smaller class of boats, lobstermen and fishermen, usually first find them, and report their whereabouts, sometimes with ranges for locating them. Of these ranges and the area they will cover, "custom cannot stale their infinite variety." There is not often much discount about there being a rock or ledge at the given depth of water, as quite likely they have got this information by an impressive and uncomfortable experience.

Once, while working in Maine, I had direction from the military engineer officer by whom I was employed to look up and survey a ledge of rock that some shipmaster had reported, saying that they would show me where it was. Although the place was an estuary not

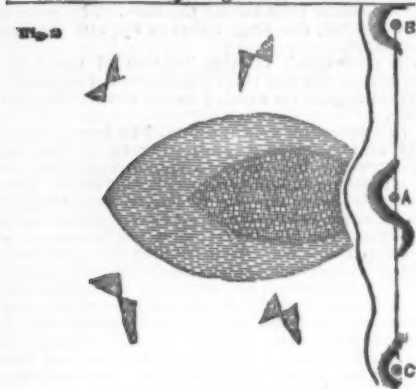
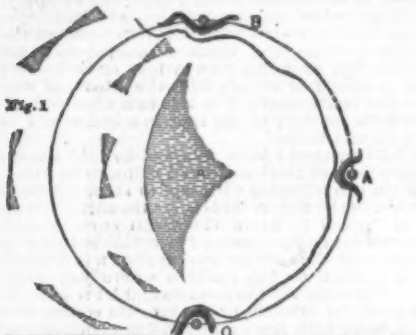


PLATE II.

tions cover all good cases of location. Taking Fig. 1, Plate II., if the stations A, B, C, are in this position, the outer stations at each end of a diameter of a circle and the central one 90° distance in the same circumference, and the intersection point say in the center of the circle, you have the best possible location; but the locality would be rather an uncommon one to allow choosing the stations in those positions. The field of operation too is small, as given in the broken hatched lines; not even so much area as the 40° to 100° limit angles would cover, the intersection of the circles becoming poor before these limits are reached.

Take the stations as placed in Fig. 1, Plate III. These, I consider to approach the best, placed as they are in the circumference of a circle sufficiently large not to hazard any risk of the location point being near it, and yet enough of a circle to make an extended area for work. In Fig. 2, Plate II., the stations are in a straight line.

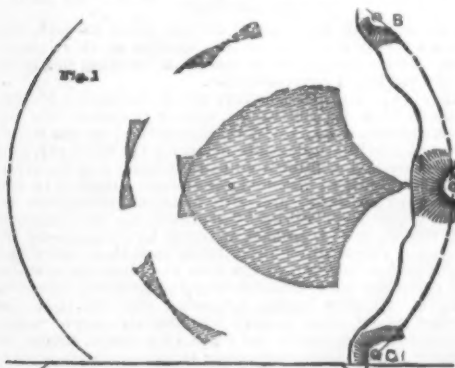


PLATE III.

This is a convenient arrangement at times. There can be no circle passing through them and the intersection point. At the same time the field of operation is small. This is increased very much by making the limit of angles 30° to 120°, as shown by broken hatched lines crossing the others at right angles.

The station can also be in a circle curving slightly outward, but the field of operation is made still smaller.

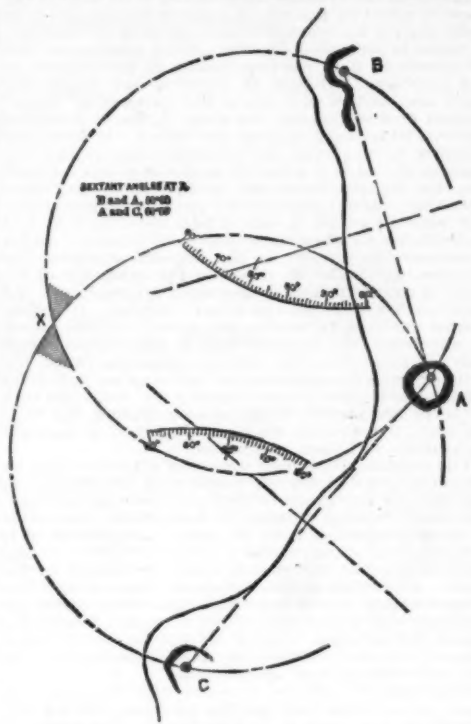


PLATE IV.

more than two miles across, they could not place it within a quarter of a mile. I explored all around with a sounding iron, but could not find it till later, with a dredging machine; it was found with gravel and small stones covering most of its surface. A person skilled in the matter will tell a sunken rock by watching the break of the waves over it, when there is the right amount of wind and sea. I have known rocks of no great size to be found in this way a number of feet below the surface.

I will speak now briefly on the navigation of vessels, and the methods they use. Those cruising along shore, like the boats to the southern ports—and the same might be said of the transatlantic lines that follow one pathway—can be almost sure of making their runs without accident. I hear you say, "How about the City of Columbus?" but I will pass on. When leaving port they take from a certain fixed point, like a lighthouse, a compass bearing, estimating the distance,

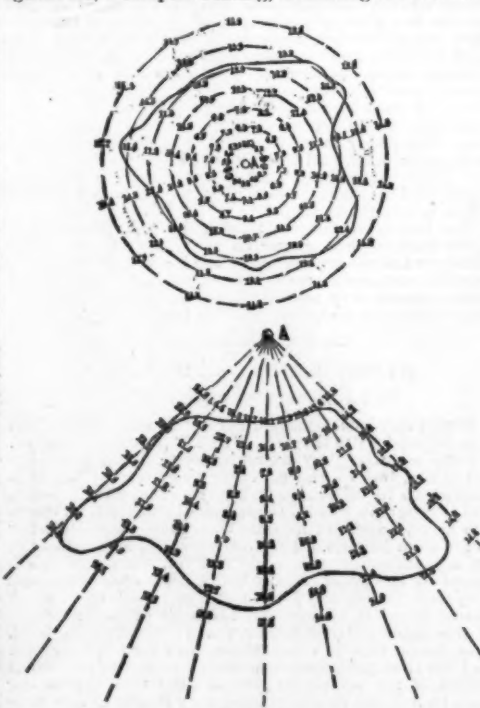


PLATE V.

or two bearings are taken to fixed points shown on the chart. This is called taking a departure. This point is plotted on the chart and a course laid out to the next point it is desired to make. The variation of the compass is then allowed for and the corrected course given to the quartermaster, or whoever the man may be that steers the vessel. Many a ship has been lost by putting this correction on the wrong side. With the patent

log now in use the distance run can be nicely made with care; that is where it all comes. What the plumb line is to the engineer, architect, or mechanic, the sounding line or chain is to the hydrographic surveyor or navigator, only with the latter class it is not enough used, and simple though it may seem, they do not generally know from want of practice how to well use it, outside of smaller craft like fishermen, and the war vessels. If beyond the sight of land, the methods of obtaining the latitude and longitude must be employed. If a vessel's position is determined within a mile after being out any length of time, it is considered fine reckoning. The ways followed are not hard, but the *be sure you are right* qualities are needed. These calculations were ciphered down to their simplest elements by the grandfather of one of our fellow members, Nathaniel Bowditch, who, although a renowned mathematician himself and one who had hung to his name a long list of learned societies, appreciated perhaps more than any one who ever prepared a practical or working treatise the necessity of placing his methods within the comprehension of the class of persons for whom they were intended. He expected his auditors to know next to nothing, and he was not always far out. The longitude is found by taking an altitude of the sun, at about nine o'clock in the forenoon or three in the afternoon, a time when it moves the fastest to the eye of the observer.

At the instant the altitude is noted, the time of the chronometer is taken, and on the niceness with which this is done depends the accuracy of the position. This altitude worked up by a formula gives the time of day as given by the sun; it is converted into mean or clock time. The chronometer gives the mean time of Greenwich or any other meridian. The difference is the longitude. The latitude is obtained by an altitude of the sun, when on the meridian, and is found by a calculation even more simple.

While the principles required are few and plain, and the manipulation easy, the details to be mastered, and practical skill, are by no means inconsiderable. It is not a training that is gained in the schools, which, to a certain extent, be it more or less, make an engineer. Among the uneducated are often the most skillful, that is, those who do not lose their vessels, if only their bump of observation and locality is abnormally developed.

Have you not met in your railroad surveys men whom it was nearly impossible to lose, or turn around, in darkness or stormy weather? They have the qualifications that make a navigator.—*Journal Association Engineering Societies.*

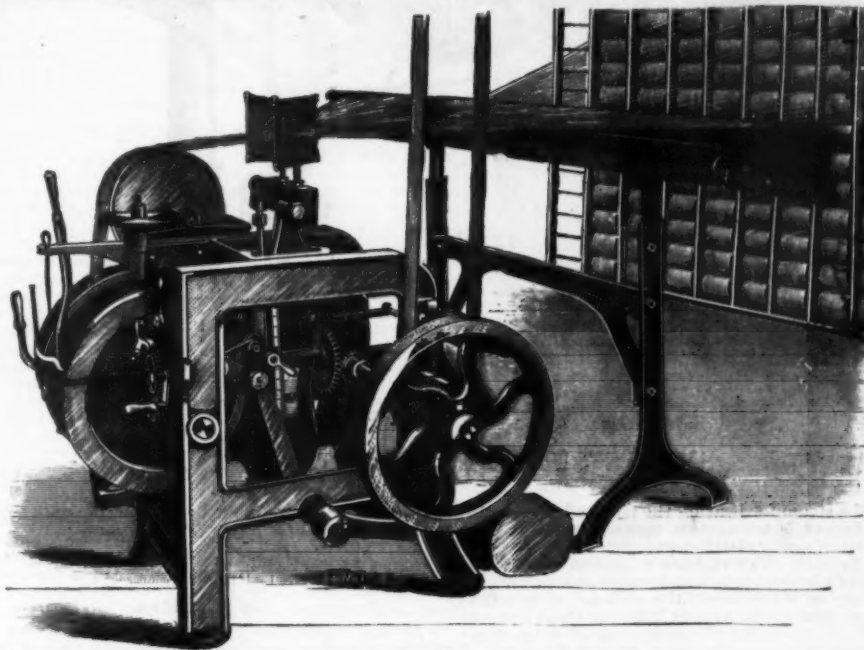
THE AUSTRIAN POST TRICYCLE.

THE velocipede developed from a mere plaything for children, first to a sporting article and then to a vehicle for practical use. It could, of course, be of no value for the last-named purpose until it had been provided with many technical improvements and alterations, since the addition of which it has become a type of machine which can scarcely be improved; that is, if we set aside the still unsolved question of steam, compressed air, or electricity as a motive power.

The sporting vehicle, which was at first ridiculed whenever it appeared outside of the race course or the practice ground, has, within the last few years, made as triumphant an entrance into all parts of the civilized world as the sewing machine, which was at first laughed at by all.

As we have already said, there is very little chance left for improvements in velocipedes, except in details of construction which will better adapt it to its various uses. Steamboats, locomotives, carriages, wagons, and cars are constructed differently according to the uses for which they are intended, and it must be the same with that most modern of vehicles, the velocipede. One of the newest types is the tricycle which has lately been adopted by the post office department of Vienna, which was constructed from the designs of the velocipede specialist, Mr. A. Curyel. It is used in collecting the mails from the letter boxes in the city. These letter boxes, which are the invention of a Ger-

man, are so arranged that they are emptied into a leather bag, and the box and bag are automatically opened and closed in such a manner that the person who empties the box can neither see nor handle the mail matter. The collector empties from ten to fourteen letter boxes on each round, and carries the mail matter back to the post office in one or two locked bags, as the case may be. The maximum weight which he carries on his tricycle when both bags are full is about eighty pounds. In making the tricycle, attention was given to the load to be carried, the easy steering of the vehicle in and out among other vehicles, the steep ascents to be climbed, the bad condition of the pavement in many streets, the requisite strength as well as lightness of the machine; in a word, all the local disadvantages under which the post tricycles had to operate were taken into consideration.



IMPROVED WARPING MACHINE.

The construction has proved entirely satisfactory, and the administration is much pleased with the introduction of the tricycle, as much expense is saved thereby, and the new method of collecting has many advantages over the old one. The boxes were formerly emptied by collectors who went their rounds in one-horse wagons, each wagon requiring a special driver. By the use of the tricycles the horses and the drivers are dispensed with, thus greatly reducing the expense of the department. The service can also be more quickly and safely performed.—*Illustrirte Zeitung.*

IMPROVED WARPING MACHINE.

NOTWITHSTANDING the great development of the cotton trade, and the consequent increase in the number of large establishments in which the older system of ball warping has generally been discarded, there yet exist a number of smaller mills in which the latter form, from economical reasons, is still retained. The difficulty, however, of controlling men warpers, and especially the great cost of their labor with the old reel warping mill, has led to important modifications in the system of ball warping that have increased its efficiency,

improved its work, and have rendered it more economical. These ends have been attained by the invention of section warping mills and the introduction of female labor. The old reel mill has therefore given place to a younger rival, the section warping mill, to an improved form of which we have pleasure in drawing the attention of our readers.

The machine to which we refer is made by Mr. J. H. Stott, Baron Street Works, Rochdale. In a less perfect form than the present it has been in the market for a year or two, but the improvements recently effected give it a new title to our notice. The object the inventors have sought to attain has been that all the sections which go to make a warp shall be equal to each other in diameter, and shall each contain the same length of yarn, wound with a perfectly uniform tension. The latter is important, because should any difference exist

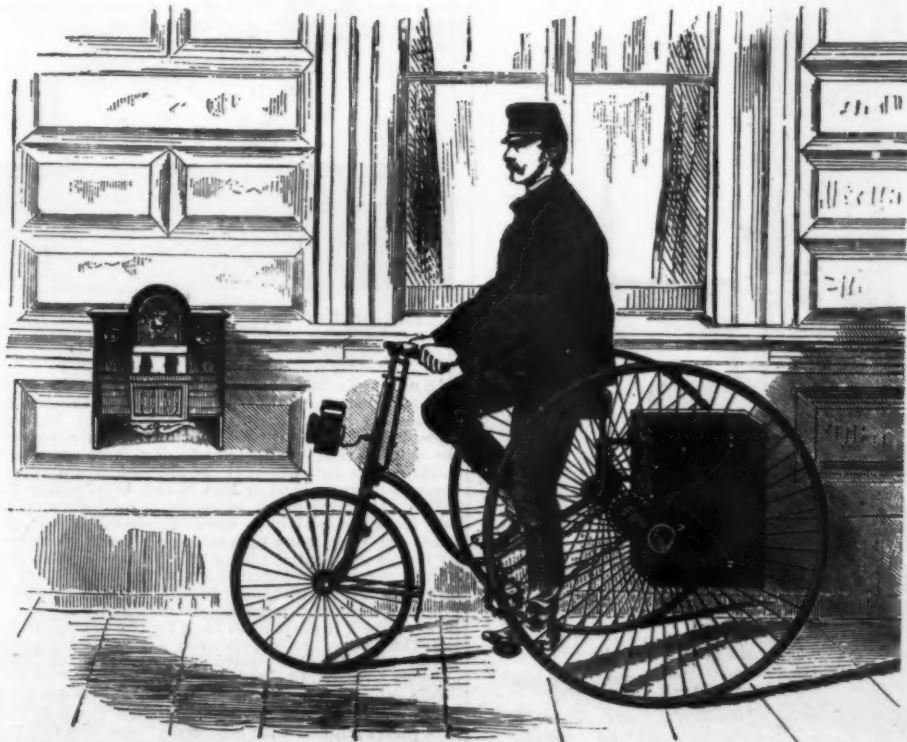
in this respect in winding off the sections to form the warp, waste would occur at the end; or should the defect get past this point it would prove more serious in the loom, because all the strain induced by shedding would have to be borne by the highest tensioned portion. This would result in numerous breakages of warp threads and a considerable depreciation of the quality of the cloth. Besides obviating these difficulties, it has been sought to obtain several advantages in details by an improved arrangement of the parts. These will appear in the subsequent description.

The general aspect of the machine will be gathered from the accompanying illustration, while the following description will enable the reader to comprehend its details. On the section shaft is a cam which actuates a ratchet that gears into a wheel upon a screw, and which is traversed by the revolution of the latter. Upon the end of this screw is a fork carrying a pair of links which operate two vertical levers, one having its fulcrum at the bottom and the other at the top. By these means is secured a perfectly parallel movement of the screw. Between the levers just mentioned is a double swing lever in two parts; between and into this is inserted a screw, the function of which is to regulate the tension, and which is adjusted by the small handle at the top.

In starting work the two parts of the double swing lever are brought to a vertical position parallel with each other. Arranged above the two horns or projections of these levers, and upon a vertical pillar, is a compensating weight, which, as the section warp increases in diameter and the horns separate from one another, falls down between them, pressing against them, and preserving the highly desired uniformity of tension. The driving shaft upon its extremity carries a bevel wheel gearing into another upon a cross shaft, the latter carrying a friction bowl which presses against one of the section flanges, and by causing it to revolve winds on the yarn. In order to provide for the making of sections containing selvage threads, the section shaft is furnished with a second friction plate, so that by bringing the friction bowl against this plate, instead of the first, the direction of the winding can be reversed, and the selvage ends placed outside. Exactly the same process serves for making patterned warps.

The machine is fitted with a curved reel and a patented curved heck, which secures the uniformity of length of yarn wound upon the series more perfectly than can be obtained by the employment of a straight heck. The heck eyes are made of cast steel as hard as it is possible to make them. The half beer-leasing reel is fitted with a right and left hand screw, by which means the width of the section is easily regulated. The measuring roller is 18 in. in circumference, and by a train of carrier wheels works the indicator. The section blocks are made solid, but if desired by the purchaser expanding blocks can be supplied. These, of course, obviate the necessity of keeping a large number of blocks in stock where various sizes of sections are made. In warping unsized yarns the sections are balled off together by an ingenious balling machine, after which they are ready for the sizing process. In working colored warps in which the sizing has been previously performed, they are run straight upon the loom beam in the ordinary manner.

It will be apparent from what has been said that this machine possesses several important features that will commend it to the notice of our practical readers, any of whom may gain further information, or the opportunity of inspecting it, by application to the maker, as above.—*Textile Manufacturer.*

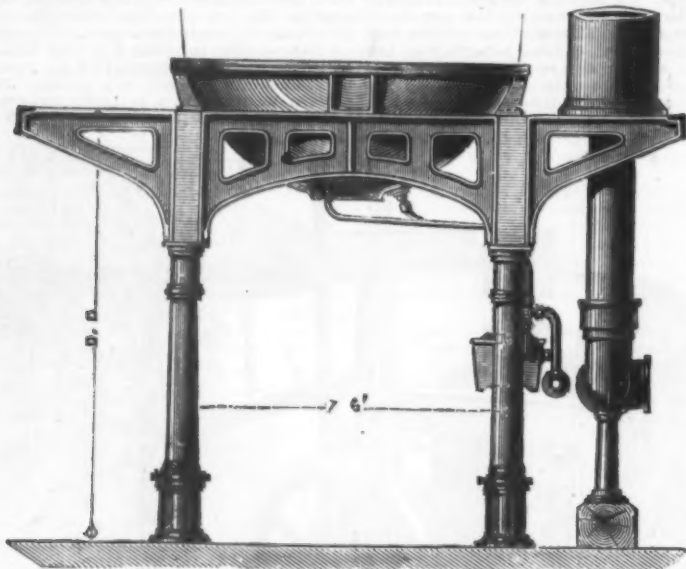


THE AUSTRIAN POST OFFICE TRICYCLE.

IMPROVED SUGAR MACHINERY.

AMONG the machinery and apparatus exhibited by Messrs. A. & W. Smith & Co., of the Eglinton Works, Glasgow, was a well arranged set of vacuum pan sugar boiling apparatus, as illustrated in the accompanying engravings, which are elevations and plan. These show the arrangement of the pan, engine, and air pump, with the air and vapor pipe connections, and

Sterne & Co., which gives the whole apparatus a very attractive appearance. The discharge of the pan exhibited is equal to six tons of dry sugar. The air pump for this purpose is necessarily of large size, as very large quantities of vapor arise from the large evaporating surface exposed in the pan. Frames fitted with glass for inspection of the charge of sirup which is being crystallized are fitted to the upper part of the pan cover. The exhaust steam from the engine passes



SMITH'S SUGAR EVAPORATING PAN.

those of the steam for heating the pan and driving the engine. Before entering this vacuum pan the cane juice is preliminarily clarified and concentrated up to a certain density. The vacuum is formed in the pan by means of the double acting vacuum pump, and the heat is supplied by means of the exhaust steam from the engine, passed into a space between the outer and inner bottom, which are of copper, and also by steam inside copper coils or serpentines within the pan. A partial vacuum is formed within the boiling or vacuum pan, and maintained so that boiling takes place at from 150 deg. to 160 deg. Fah., crystallization being thus performed with immunity from burning, and with economy. These pans are generally elevated, as shown, on a raised platform, so that the sugar discharged from the bottom may be run into a series of tanks for cooling, or direct into the hopper of a centrifugal drying machine, in which the sugar is purged from molasses. There is no special feature of novelty in the apparatus, but the general arrangement and the details are worked out with care and the work well finished. The body and top of the pan are lagged with ebony and whitewood; the fittings and gauges are of argozoid, the white metal made by Messrs. Louis

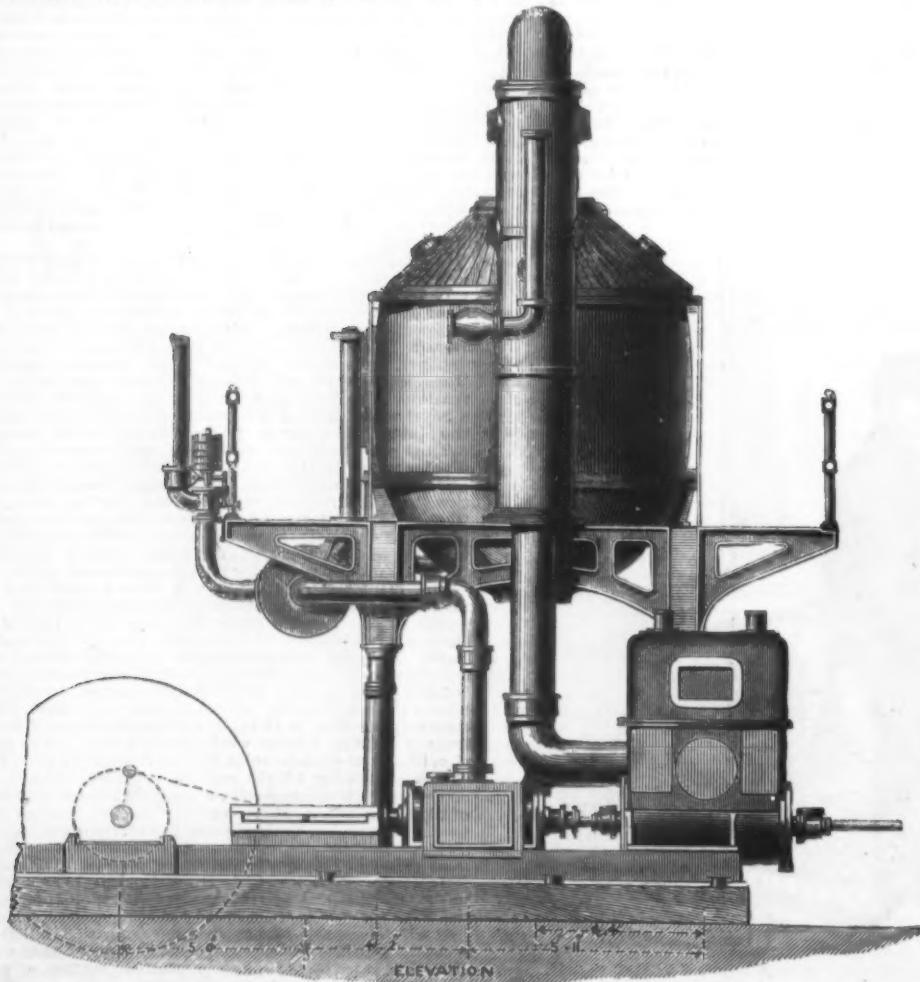
into a large receiver, and thence into the space between the inner and outer pans.—*The Engineer.*

HEAT PHOTOGRAPHY.*

By F. E. IVES.

AT the November meeting of this institute, I described certain experiments in photographing by the aid of the phosphorescent tablet, and announced the discovery of a means of photographing obscure objects by the action of heat radiations. Since then, I have made several camera photographs of metallic objects by the action of obscure heat rays, which I placed the objects in a position to reflect. With a source of heat, produced with the consumption of coal gas, at the rate of only three feet per hour, I obtained strong heat photographs of small metallic objects, with camera exposures of only ten seconds. But, although a moderate amount of heat was sufficient to give such striking results, it proved to be necessary, under ordinary conditions, to

* This term may be objected to, but has been employed because the result of the method described is a fixed photograph of a fugitive thermographic impression.



IMPROVED VACUUM SUGAR EVAPORATING PLANT.

employ heat of a certain quality or intensity, which can be obtained only when the source of heat is also a source of light. My source of heat was the incandescent line of the oxyhydrogen light, placed in a dark box, one side of which was of black glass. The black glass transmits about thirty per cent. of the intense heat rays, but no rays capable of producing phosphorescence, or of affecting bromide of silver. The arrangement is shown in this diagram:



a is the metallic object, b the camera, c the dark box containing the source of heat.

The object was focused by the light rays, allowance being made for difference of refrangibility of the heat rays. The light was then extinguished by the black glass, and a solarized phosphorescent tablet exposed in the camera. As I explained in my preliminary communication, this exposure produces a dark impression instead of the luminous impression that would be produced by violet light, and the photograph of this impression, made by contact printing on a photographic sensitive plate, is, therefore, a positive instead of a negative.

I attempted to substitute a hot iron for the incandescent line as a source of heat, and even to photograph the hot iron itself, but without success. This might seem to indicate that the tablet is not sufficiently sensitive to the feeble heat rays radiated by objects not heated to incandescence, but a simple experiment demonstrates that such is not the case. Contact with the hand for a single second will produce the characteristic sudden exaltation and partial exhaustion of phosphorescence in a tablet that has been kept at a sufficiently low temperature after solarization, and a simple calculation will show that enough heat is radiated from the hot iron to produce, in a little while, a strong impression in a camera some feet away. The knowledge of this and of the fact that rock salt lenses transmit, and metallic mirrors reflect, these feeble heat rays, led me to hope that I might photograph obscure objects without having to secure the special conditions that now appear to be necessary. My failure with the hot iron proved to be due to absorption of the heat rays by aqueous vapor in the air. Professor Tyndall found by experiment that the aqueous vapor in the air of his laboratory absorbed seventy times as much heat as the air itself. My experiments were conducted in very damp weather, and nearly all of the heat radiated by the hot iron was evidently exhausted in warming the air, and was carried away in air currents. Although I did not accomplish what I hoped to in this direction, these experiments have made it evident that in a perfectly dry atmosphere it would be possible to obtain photographs of obscure objects by the action of heat rays of low intensity.

I have two illustrations of the method. One is a heat photograph of a German silver key check, the other a photograph of the impression produced on a solarized phosphorescent tablet by the lime light spectrum. The key check photograph is quite small, but reasonably distinct. I believe it is the first heat photograph of an object that has ever been exhibited. The shadows of three pins are reproduced in the spectrum photograph. One was in the violet of the spectrum, another in the yellow, and the third at the lower limit of the visible spectrum. The photograph proves what I have already asserted, that in Balmain's paint, phosphorescence is produced chiefly by the violet rays, and the dark heat rays below the visible spectrum act most powerfully to exhaust that phosphorescence. Exposures on the solar spectrum gave substantially the same result, but showed relatively more action by luminous heat, and distinct but very feeble action in a portion of the ultra violet spectrum—the latter action was utterly insignificant as compared with the action of the same rays on bromide of silver.

Obscure Heat,
Red,
Yellow,
Green,
Blue,
Violet,
Ultra-Violet.



LIME LIGHT SPECTRUM ON SOLARIZED PHOSPHORESCENT TABLET.

In my preliminary communication, I stated my belief that certain results that one M. Chas. Zenger recently claimed to have obtained by the aid of Balmain's phosphorescent paint could not have been obtained in the manner that he described. My later experiments confirm this belief, and I would not again refer to Zenger's communication had it not been widely published, attracting much attention. Balmain's paint is but feebly sensitive to invisible chemical rays, glass lenses are practically opaque to all heat rays radiated by bodies not heated above 200° F., and even a moist atmosphere will not transmit the feeble heat rays to any considerable distance. If Zenger obtained a photograph of a midnight landscape in exactly the manner he described, it must have been by the action of light rays that would have produced a much stronger and better photograph by acting directly upon the photographic sensitive plate itself.

One other statement of M. Zenger's calls for correction by me. He asserts that collodion bromide emulsion plates stained with chlorophyll are sensitive to all parts of the solar spectrum "from ultra violet to ultra red." More than seven years ago I discovered and pub-

lished the fact that such plates are so remarkably sensitive to all colors as to be capable, with the aid of a weak yellow light filter, of producing correct color tone photographs of all colored objects. But it is not true that the sensitiveness extends to the ultra red rays. It stops abruptly at the Fraunhofer line α , in the red, as shown by spectrum photographs that have been made on such plates.—*Journal Franklin Inst.*

CORK AND ITS APPLICATIONS.*

THE various applications of cork that we are now going to pass in review are worthy of description, although they do not possess the importance of the one to which our former article was devoted. Each of such applications has its *raison d'être* in one or more of the physical or chemical properties of cork bark. The manufacture of stoppers utilizes, in the first place, the

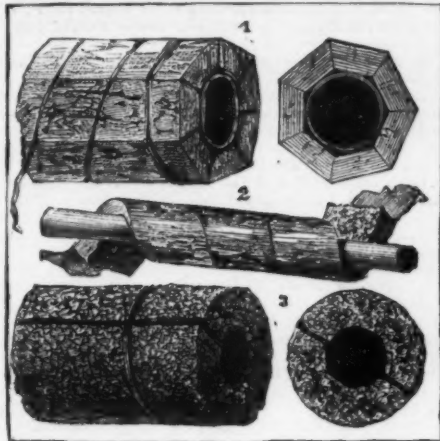


FIG. 1.—CORK JACKETS FOR STEAM PIPES.

impermeability of the bark, and, in the second, the latter's elasticity and imputrescibility—the remarkable lightness playing no role therein.

MALE CORK.

Before entering upon a study of the industrial applications of cork, in grouping them according to the various qualities of this product, we must return to the "male" cork, derived from the first barking of the tree. We have said that, because of its slight elasticity and numerous fissures, this product has but little commercial value, and we shall have mentioned its principal application when we have stated that it is used in the decoration of parks and gardens. An endeavor has been made, but without success, to manufacture from it mills for decorticating rice.

Certain parts of it can be converted into small stoppers. In the country where it is produced, it is used for making water conduits, beehives, and shelves on which to preserve objects from dampness. Mixed with a mortar of clay, the Kabyles use it for the walls of their dwellings, and also, in lieu of tiles, as a roofing material for their primitive habitations. It is used also by fishermen as floats for their nets.

These various applications were known to the Greeks and Romans, as shown by the works of Theophrastus and Pliny. The latter says of the cork oak: "Nothing is utilized but its bark, which is very thick, and which is renewed in measure as it is removed. This bark is often used for the buoys of anchors and ships and of fishermen's nets, for the bungs of casks, and for women's winter foot gear. The Greeks called the cork oak the 'bark tree.' Cork bark is used as a covering for roofs." (*Hist. Nat.*, xvi., 18.) As for the

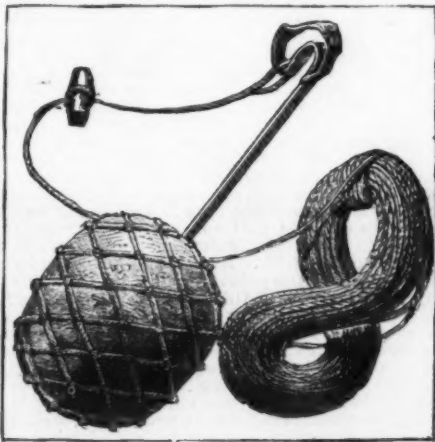


FIG. 2.—LIFE SAVING DEVICE.

chips, they can be used as an isolating material to prevent freezing. Reduced to fragments, they furnish an excellent material for covering circus rings.

FEMALE CORK.

Let us return to "female" cork, which is much better adapted for being worked, and the grain of which is much more homogeneous. In this form, cork bark constitutes a very bad conductor of heat and sound, and renders valuable services in the industries as a material for preventing the cooling of steam pipes and generators, and preventing the melting of ice in ice houses, or the heating of apparatus for producing cold. It is the basis of a certain number of cements, and of coatings for preventing the escape of heat, which are applied to pipes, steam domes, hot water reservoirs,

etc., and upon the composition of which we shall not here dwell. As for jacketing with cork alone, Fig. 1 shows three methods employed in France. The first consists in placing narrow strips of cork, whose edges touch each other, along steam pipes and cylinders, and fastening them by means of wire. A pipe thus jacketed (1) is tangent internally to all these strips, and a section of the whole shows a circle inscribed in a polygon. In the second system (2), thin strips of cork, fastened to canvas with India rubber cement, are wound around the pipe spirally. Finally, a third method of jacketing consists in the use of two half cylinders (3) that exactly fit the exterior of the steam pipe. These cylinders, which can be made of any desired length, are made of powdered cork and starch, and are covered with a spirally wound strip of calico, which may be coated with tar or any suitable kind of paint. Each of these systems permits of obtaining a great saving in fuel.

As cork is likewise a very bad conductor of sound, it is successfully used on the doors of consulting rooms, and for making floors for hospitals, etc. Finally, in the manufacture of certain stringed instruments, it is used to prevent a loss of sound.

FLOATS AND LIFE SAVING APPARATUS.

The slight density of cork, as compared with water, and its impermeability to liquids, make it an excellent float, capable not only of remaining on the surface, but also of supporting quite heavy bodies thereon. We shall be content to mention the annular cork float used in night lamps, the square block in which bath thermometers are fixed, and the fisherman's dobber.

It is cork, too, that is used by preference in the manufacture of swimming and life saving apparatus, to which inventors have devoted much thought. Very many vessels are provided with cork mattresses, which, in cases of shipwreck, render the greatest services. For example, the ship *Constant*, which sailed from Anvers for Brazil in 1845, was wrecked on the night of October 13, at twelve miles from St. Thanes, but, thanks to the cork life preservers and mattresses that she had on board, not one of the crew was lost. As for life saving buoys, properly so called, they consist of several cork planks which are given an annular form, and are provided with free ropes that are knotted here and there so that they may be easily grasped. From the stern of every vessel a buoy of this kind is suspended by a rope that may be at once cut when the cry of "A man overboard!" is heard. These buoys are usually covered with canvas coated with a paint that serves to preserve it. It is also possible to save a person who has fallen into the water at a certain distance from a wharf by means of floats such as shown in Fig. 2. The piece of wood permits of grasping the rope between two fingers and throwing the apparatus after the manner of a sling. This device consists of a piece of rattan provided with points around which molten lead has been poured, and the whole is then surrounded with cork in chips, and covered externally with canvas and a network to protect the affair against wear.

Fenders are canvas bags that are filled with cork and are placed along the sides of ships or along docks in order to deaden the shock in case of a collision. Such are the principal uses rendered to navigation by cork.

CORK CLOTHING.

We have already seen, from the extract from Pliny, that Roman ladies preserved their feet from cold by means of cork soles. Such a use of cork is still in

vogue. In addition to these soles, which are flat, there are others that have nothing to do with hygiene, and are merely connected with fashion. Such are the *Louis Quatorze talonettes*, designed to increase the stature without exaggerating the heel of the shoe. Female dancers wear linings of this kind in their shoes, which, as well known, have flat soles. A thin sheet of cork inclosed in the sole of the shoe would, we think, prove very useful to troops on a march during bad weather. Cork is not only useful as an application to foot gear,



FIG. 3.—CORK LIFE PRESERVER AND BUOY.

but also renders great services in head gear, and, in the form of helmets, has preserved a large number of our soldiers from death by sunstroke in tropical countries. We find it again, in the form of very thin sheets, in the interior of our beaver hats, where it is used as a protection against heat. It is also used in these same hats as a sweat band, in lieu of leather. In ladies' toilets, cork serves to make the carcasses of the birds that decorate their head gear. Manufacturers of dress trimmings use cork moulds, which they cover with silk or cotton, for ornamenting cloaks, etc. The lightness of cork can alone explain the great size of these balls, olives, etc., some of which are larger than a hen's egg.

A few years ago, a Paris house sold cork cravats, and we have recently seen, exposed in a show case, some children's costumes, in which the sailor's collar was of thin sheet cork decorated with colored designs. Although cork gowns have not yet appeared, we have waterproofs composed of thin sheet cork cemented between two pieces of silk. These cloaks have the advantage over those made of rubber of not allowing air to pass through them.



FIG. 4.—VARIOUS OBJECTS OF CORK.

1. Float for Night Lamp. 2. Bath Thermometer. 3. Fish Line and Dobber. 4 and 5. Cork Soles 6. Sweat Band. 7 and 8. Cork Bird Forms. 9. Moulds for Dress Trimming. 10. Cork Box and Cover. 11 and 12. Bottle Cases. 13. Silk Bobbin. 14. Inkstand. 15. Penholder. 16. Cigar Holder. 17. Watchmaker's Lens. 18. Nipple Shield. 19 and 20. Disks. 21, 22, and 23. Stoppers. 24. Cork in Course of Formation.

* Continued from SUPPLEMENT, No. 590, page 9258.

The curious application of cork in the manufacture of a fabric that renders those who are clothed with it insubmersible has already been mentioned in a preceding number.

VARIOUS APPLICATIONS.

We can mention but few of the many applications of cork, new ones of which are being discovered every day, and we shall confine ourselves to recalling the services rendered by this valuable product in surgical prosthesis and for the use of naturalists, etc. In domestic life, we see it used for bath steps, and for making rolling pins for crushing almonds without absorbing the oil as wood would do. Thin sheets of it are used for making fancy labels for wines. The ease with which it may be cut, turned, and worked causes it to be employed in the manufacture of small objects, such as rural landscapes and the reproductions of monuments, some of which are genuine works of art. We may likewise mention, among objects made of cork, cases of various forms for sending bottles by mail, spools for allowing of the cheap carriage of silk, the old fashioned ink stand, the thick penholder for preventing writer's cramp, the cigar holder, and many fancy objects that would take us too long to enumerate. There is perhaps no calling that does not have to make more or less use of cork. Polishers of gold have used it from time immemorial, in the form of narrow strips, for rubbing their work with rouge. The wheels with which crystals are polished are faced with it. In Fig. 4 may be seen a watch maker's lens mounted in cork, the lightness of which prevents the muscles of the face from tiring.

In the industries, driving pulleys are now beginning to be provided with cork in order to secure an adhesion of the belting. In carpenter shops these bands of cork are now advantageously replacing rubber ones for covering the pulleys over which the band saw runs. The stoppers of nursing bottles are now being replaced by hygienic ones of cork, which, being very cheap, can be changed as soon as the presence of ferments is suspected. Cork is likewise employed in the manufacture of children's toys; it serves, for example, for fixing the wig on dolls' heads. Is it necessary to recall the corks of pop-guns and pistols, and the cork battle-doors and shuttlecocks used for playing with indoors? These few data will serve to show that but few products are capable of so many diverse applications as cork is; and the question may be asked whether it would be possible to substitute anything else for it in case the supply should become exhausted.

The manufacture of stoppers and of the various objects that we have just enumerated furnishes a considerable quantity of chips, which, along with the waste derived from the collecting of the material, and with old, second hand corks, constitutes the crude material destined to supply certain important industries, which, for the sake of completeness, must be mentioned.

CORK POWDER.

We have, first the cork powder industry, which manufactures powders of various degrees of fineness. The coarsest powder is used for packing fragile objects, on account of its elasticity, coupled with its lightness, which permits of a great saving in freight charges.

The finest powder forms *légine* or *subérine*, whose balsamic properties are well known to hygienists, and which may be used as a substitute for lycopodium, starch, and fecula as an application to the skin of babies. Under the name of zifa powder, an insect powder has been made, composed of cork and phenol. Fire lighters have likewise been made from cork powder; but this and the last named application have not amounted to much.

LINOLEUM.

We cannot enter into much detail in regard to the manufacture of linoleum, notwithstanding the interest that it presents. The manufacture began in Scotland, and is tending to settle in our own country. Linoleum is made by intimately mixing cork powder with oxidized linseed oil. The paste thus prepared is spread over canvas if the intention is to manufacture carpets, but over paper if it is desired to make hangings. The color of linoleum, which is the same as that of cork, only a shade darker, can be enlivened by colored designs. When applied to damp walls, linoleum is capable of receiving oil paintings of a more stable nature than those executed upon wood, which warps, or upon other building materials, which crack, such as plaster, for example. It can also be used for decorated ceilings for public halls, cafes, etc.; and when such ceilings become black through smoke and dust, they can be washed.

As a carpet, linoleum renders flooring perfectly insouorous. It converts damp and unhealthy apartments into healthy and warm places of habitation. Used in kitchens and offices, it has the advantage of not being spotted by fatty matters. It has been generally adopted in our naval and merchant ships, where the use of it has given a great setback to the oil cloth industry.

A new decorative product, *lino-burgau*, obtained by embossing linoleum, possesses the iridescent reflections of naere, due to the application of colored varnish along with a bronzing of certain parts. Notwithstanding its expensive nature, we believe that there is a great future in store for it.

AGGLOMERATES OF CORK.

The manufacture of agglomerates of cork is becoming very widespread in France. We have already mentioned the use of artificial cork for jacketing steam pipes, and we have stated that this product is obtained by agglomerating cork powder and starch under pressure. This dried paste can be given the most diverse forms, and be made of any thickness. Another substance, called brick paste, is obtained by agglomerating the coarsest cork powder with milk of lime, and, after compression and drying, constitutes, under the form of bricks and slabs, an excellent material for the construction of party walls, for covering damp walls and sloping roofs.

In the cellars of breweries, these bricks diminish the melting of the ice. In gunpowder works, they prevent the caking of the powder through dampness, and, in case of an explosion, their friability and lightness lessen the importance of the catastrophe. They are also used as a foundation for flooring in order to destroy its disagreeable sonorosity. In the spinning mills of

Alsace and the west of France, they have given excellent results, both as regards their resistance to the passage of sound, heat, and cold, and their cheapness.

CORK GAS. SPANISH BLACK.

Cork chips and waste, when distilled, furnish an illuminating gas that burns with more brilliancy than that made from coal, and does not, like the latter, give off sulphureous emanations that tarnish frames and other gilded objects. The city of Nérac was lighted with cork gas for a certain length of time, but the use of it had to be given up on account of the difficulty of storing the chips, which, with but little weight, took up an enormous space. This gas, in view of its slight density and its purity, would prove an excellent one for the inflation of balloons.

Finally, cork parings and waste, properly carbonized, produce Spanish or cork black, one of the most beautiful and durable blacks known in painting.—*A. Good, in La Nature.*

(Continued from SUPPLEMENT, No. 586, page 9410.)

PRINCIPLES AND PRACTICE OF ORNAMENTAL DESIGN.*

By LEWIS FOREMAN DAY.

LECTURE III.

THE FITNESS OF ORNAMENTAL FORM.

WHENEVER a point of art is the subject of discussion, the difficulty of coming to a clear understanding is increased to an incalculable degree by the totally different meanings attached by speakers to the terms, more or less technical, one cannot avoid using. To begin with definitions would not greatly help us. No sooner should we have commenced to define, than we should find ourselves stumbling against other words equally in need of explanation.

What a flood of light would be let in upon the question of decorative design, could we but agree among ourselves as to what is meant by the term "conventional"! An English artist understands by conventional treatment such a rendering of natural forms as may be consistent with the decorative character of the work in hand. It implies to him that self-restraint, that intelligent selection, that recognition of the ma-



FIG. 16.

terial and its characteristics, that strict regard for the purpose and position of the design, without which ornament does not so much as deserve the name of ornament.

To a Frenchman, on the other hand, it stands for all that is helpless and hopeless in art. Nothing remains to be said of that which he has stigmatized as "convention." In that one word he has expressed his supremest contempt for it.

Do not suppose that I mean to say it is merely a matter of nationality. Of course, not all Englishmen are agreed as to what they mean by the word conventional, nor all Frenchmen probably; but there is in its general interpretation in the two countries an explanation of the respect, as of the contempt, in which it is held.

The Continental use of the word is perhaps the more exact. The conventional is literally that which has come to be accepted; and as a matter of experience, we find that little or nothing is ever universally accepted until it is already tolerably stale. The accepted thing becomes, therefore, identified with all that is insufferably tedious in modern art. There seems to be no hope or promise in it; it stands for stagnation.

Yet there is another side to the question. We find in the best work of certain periods, and of certain peoples, certain principles which appear to have been generally obeyed; so universally obeyed, indeed, as to warrant us in calling them the principles of decorative art. In endeavoring to explain those principles concerning which we have to come to some sort of general understanding or agreement, the party of reform adopted, in an evil hour, the term conventional to express that kind of treatment which, whatever it might be, was adapted to the purposes of decoration. But it proved less easy to grasp the elusive spirit of design than to take possession of the forms in which it was embodied. And the cut and dried character of the examples of design adduced by way of illustration led to the supposition that the conventional was nothing more nor less than the trite, the literal meaning of the word leading itself to the confusion.

One may take it that the artistic verdict on conventionalism is mainly according to the artists' interpretation.

* A series of four lectures recently delivered before the Society of Arts, London. From the Journal of the society.

tion of the word. If by conventional ornament we mean perpetual variations on the same old tunes, tunes long since played out; if we mean adherence to the well worn types; if we mean affectation, imitation, mimicry, a bigoted belief in the letter of the law as it was in the days that are happily past, no one of any originality or invention of his own—no artist, that is to say—can consistently belong to the party of convention.

If, however, what we understand by the term is the spirit in which the past masters of ornament accepted nature as a never failing source of inspiration, reverencing her most deeply, aye, and following most truly, in that they were not content to copy, without further thought, the forms nearest at hand, in that they did not imagine for a moment that what she had made fit for her ends must, without modification, perforce be fittest for their very different purposes; then it seems hard to understand how ornament can properly be anything but conventional. A fitter term might be found for it, no doubt. I prefer myself the very expressive word "apt;" but in discussing the thing we cannot well ignore the word by which it is currently known—and we find the word "conventional" in possession.

One can scarcely conceive of ornament which is not, in a manner, more or less modified by considerations altogether apart from the natural forms on which it may have been founded. Even the human form, which is our highest type, and with which less liberty may be taken than with any other of nature's work—even the human form is not ready made to the hand of the sculptor; and the works of the great masters to which we accord the title of "monumental" are so in virtue of a something which was not in the model of the sculptor, but in his art. Call this subtle quality what you will—conventional, traditional, monumental, ideal, individual—something there is in all applied art (in all art for that matter, but I am speaking now more especially of decorative and ornamental art), something which is, I will not say contrary to nature, for it belongs inherently to human nature, but non-natural in the sense that it is not borrowed directly from natural forms.

The very position and purpose of ornament, the method of its execution, and even its construction, insist upon some treatment of natural forms which, for want of a better word, we call "conventional." First, in reference to the construction of ornament. Its mere repetition (which, in a former lecture, I showed to be inevitable) would of itself render such treatment necessary; and even without the inducement of economy, which compels the use of a machine, we should still resort to repetition, if only because the human brain cannot go on inventing without intermission, but needs the comparative rest of repeating itself, even in hand work. In the artist's repetition of himself (unless, by some unhappy chance, he too happen to be a machine) there will always be a certain degree of variety, which there could not be in mere reproduction. But he cannot afford to dispense with repetition, nor need he wish to dispense with it. It is in itself a decorative element in design; it exhibits order, and gives scale. The only question is, where and to what extent we should avail ourselves of it.

In proportion to the naturalism of a design, and the point of realism to which it is carried, it becomes unsuited to multiplication. To put it the other way about, the oftener it is proposed to repeat a form, the more imperative it is that it should be removed from the imitation of nature, and the further it should be removed. It needs, in short, adaptation to the purpose of repetition, and it is adapted only in proportion to which I may call its reticence. A highly elaborate and attractive feature—anything, certainly, that is in the least self-assertive—will not bear so much as reduplication, whereas any insignificant device may be multiplied *ad infinitum*. In anything of the nature of a background (and so many manufactures are intended to serve only as backgrounds) repetition is of the utmost service; and repetition, as I said, implies modification.

The want of some such modification is very strongly felt in figures which are repeated over and over again. There is an instance of this in a frieze of figures on the wall, which was executed some years ago in wall paper. Notwithstanding the decorative treatment of the figures, with every repetition their charm would be discounted. There is a similar, and even a stronger, objection to the frieze next in order. Those same little boys in the same little boat would occur with exasperating regularity round the room.

Against the nursery wall papers first made popular by Mr. Crane, the latest of which is shown, there is not so much to be said. For such a purpose there is no great harm in degrading, once in a while, the human figure to the office of pattern work. The artist must be allowed to put off his dignity now and again, and indulge in an artistic frisk. Even a bad joke may be occasionally more to the point than an everlasting and deadly seriousness; and this is an exceptionally good one.

The presumable reason for introducing figures into monumental design is for the sake of some added interest or suggestion there may be in them. But you cannot get up any absorbing interest in a series of figures all identically of one pattern. They suggest too much the means employed in producing them. The multiplication of the figure, far from multiplying its interest, diminishes it in exact proportion to the number of times it is repeated. And though it be a very good thing that is repeated, the case is not greatly mended—it is so easy to have too much of a good thing. The only safety is in toning down the repeated form until its recurrence ceases to be very obvious. This may be effected in various ways. In certain leather paper, and such like designs, it is brought about partly by the low relief of the stamping, partly by the softness of the coloring, and partly by a more or less cunning complication of the Cupids (or whatever it may be) with the rest of the design, so that they do not thrust themselves into notice. The consideration which occurs in such a case is whether it was then worth doing. Perhaps not. Except that ornament has a way of being a trifle too ornamental; or rather, I should say, too monotonously ornamental; and the introduction of any bold mass, such as the figure very readily gives, is one obvious way out of the besetting danger.

Even with regard to birds, beasts, and all such living,

and especially moving, creatures, there is a *prima facie* objection to their repetition. In the case of a wall paper design such as that shown on the wall, one can scarcely help regretting that it was not executed in tapestry, with a whole pack of hounds in full career, and a family of piping Pans; but that is to regret that wall paper is a makeshift, which it undoubtedly is. All manufacture is a makeshift for handwork. We ought rather to be satisfied that the makeshift should be as good (unless by any chance we happen to be workers in tapestry).

The advisability of introducing animal forms into mechanically repeated manufacture depends entirely upon the possibility of keeping them in appropriate subjection—in their place, in fact—which in turn depends upon the art of the artist. There is a lesson in the artful way the woodland creatures with which Mr. Crane has peopled his scroll are kept down. Everything is subdued to what may be called the tapestry key. The forms which first take the eye are the bold lines of the leafage, among which the live things are more than half hidden. It is only by degrees that one becomes fully conscious of them all. That sort of mystery in a design is always delightful. The perfection of design is reached when, however attractive at first sight, it continues to grow upon you, and the more you contemplate it the more you see in it.

Observe that the natural forms I have been condoning in decoration are in all cases decoratively treated. Natural as they may be in design, they are yet more ornamental—they are not painted, for example, as Landseer would have painted them. The objection to naturalism, or perhaps I should say literalism, in forms repeated applies not only to animal, but even to floral forms. It exists in a less degree, inasmuch as they are of less prominent interest; but for all that it exists. The charm of the simplest flower is lost when we see, side by side with it, so many copies of it—not varieties, as they would be in nature, but stereotyped repetitions of the same thing.

The artist yields too readily to the temptation to make a beautiful drawing, forgetting that that is not at all the important point in decorative design, but the effect of the thing in execution, and in its place. Nor is he held in check by the public judgment. Few persons have experience enough not to be misled by the prettiness of a drawing, or the effectiveness of a sample, and so one has slight encouragement to resist. Every artist likes, of course, to make a good drawing. But, if he thought twice about it, he would realize that in very self-defense he is bound to consider the repetition of his design, and all else that concerns its use, and, if he is really a designer, he will know how to make capital of the very poverty of the conditions to which he submits. Submit he must—better do it, then, with a good grace.

Some adaptation of natural forms, some simplification in fact, is demanded not only to fit them for repetition, but, further, by the position and purpose of the work, sometimes in order that the detail may not assert itself too much, sometimes in order to give it the emphasis that is necessary.

For example, an infinity of delicate and laborious work is many a time misapplied upon details of domestic furniture, which not only pass unnoticed, but which ought not to attract notice. It often seems as if the workman had set himself to show how far it was possible to go in the direction of minuteness of detail. He may show that, and at the same time illustrate the futility of going anything like so far.

In proposing to carry execution to a point beyond what has hitherto been attempted, it is as well to ask one's self whether there may not be good reason why the attempt has never been made. Our forerunners were not all of them fools, we may be sure. As a *tour de force*, once and again, anything may be admissible, but a good workman rarely indulges of his own accord in that kind of "brag" (there is no better word for it) which exhibitions, international and other, have done so much to encourage. He is loath to waste labor, and he knows how to make his work tell without shouting at you. Often he simplifies, with a view to making his work tell often in its place. In wall decoration, for example, to be seen from some distance, a merely natural representation of the forms employed would go for very little. By the omission of multitudinous detail, he manages to emphasize what he is anxious to preserve, he even exaggerates the more important features in his design, which otherwise would lose all character at the distance from which they were meant to be seen.

Over and above the omission of irrelevant detail, and the exaggeration of characteristic forms, he modifies their natural color, and may be enforces his design by the very conventional means of an outline.

A word or two as to outline. It is often of such use in ornament, and so often useful, that it has come to be accepted by certain theorists as a necessity of the case. To them it is the passport of "the decorative." But useful as an outline is in decoration, it is not inevitable, nor is it so easy to say just where an outline should be used. Art is not by any means to be learned from aphorisms, and if recipes were of any use at all, it would be mainly to those who were not much in need of them.

In very many cases, the material and its workmanlike employment necessitate an outline, and even determine its color, as in the case of the yellow metal which marks the cells in which the paste of enamel is laid, or fix its thickness, as in the lead work by means of which a stained glass window is held together. In all such cases it is only reasonable to follow the lead given us. It does not do to play altogether from your own hand. The material is, so to speak, our partner in the game of decoration.

It is seldom, however, that an artist will resort to his own free will to an even and rigid outline all round every form. Excepting at a great distance from the eye (where its mechanical equality is not seen), that is almost certain to result in hardness—a defect which, I am sorry to say, is very commonly looked upon as a merit of execution. Mechanical precision is too often the manufacturer's ideal of finish. It is one, unfortunately, which he can all too easily realize, at a loss of what beauty of feeling and color he can probably never be brought to know.

The instinct of art is rather to lose an outline, more or less, in places, and only to insist upon it where its value is sufficient to justify the risk its use entails. The only rule which can be laid down as to the use of outline is so extremely simple as not altogether to satisfy

the doctrinaires. If the need of an outline is urgent, then adopt it; but if no such want is felt, if the effect is satisfactory without it, why on earth should one insist upon its use? For a reason—yes, but not otherwise, surely. The insistence upon outline for the sake of outline, as though decoration were not decoration without this official stamp of pedantry, this trade mark of the decorating shop, is pure nonsense.

The truth is, outline is frequently just a matter of trade expediency, and no more. And a very wise and fit expedient it is, if only in view of that process of reproduction which, as I have said, is one of the necessities of modern decoration, and particularly of modern



FIG. 17.

ornament. The vaguer forms which depend so much upon the touch and feeling of the artist do not lend themselves to this necessity. Now, an outline does. And if, in outlining his drawing, the designer cannot help in some degree hardening it, the evil is infinitely less than if the more undefined and delicate forms had been left to the tender mercies of another. Possibly he may find his reward in the executed work, in which, if he has been at all equal to the emergencies of the case, he will find again a delicacy equivalent to that of his original drawing.

Even in autograph work, where the artist executes his own design, he still avails himself of outline. Decorative art is a kind of shorthand. Its very existence seems to depend upon its being done with readiness, quickness and certainty, so that he who runs may read. That which asks for careful scrutiny to be appreciated will, for the most part, fail to win appreciation. It may have all manner of merits, but if it hides them, it has no right to complain that men pass it by. Poetry itself that is over subtle is not popular, and decorative art is essentially popular art.

The effectiveness so much to be desired in decorative art has to be obtained without many of the resources of which the painter is free to avail himself. It is not often that we can indulge in extremes of light and shade, nor yet in very strong modeling, and under these circumstances, an outline is invaluable in helping



FIG. 18.

to detach figure or ornament from its background. It is wonderful to see how effectually even a delicate outline will sometimes do this.

In work placed at a great distance from the eye, outline is, if not actually necessary, at least the simplest and most available means of definition. The greater the distance off, and the less the contrast in tone and color between the design and its background, the more urgent something of the kind becomes. For all that, there is no law making an outline compulsory, unless the artist feels the need of it. He may, if he please, detach his pattern from the ground by deepening the

one, or lightening the other, or by doing both, but that would ordinarily be a much more laborious business. Besides, it is only fair to assume that there was some reason for the choice of tones adopted in the first instance, and it may be anything but desirable to modify them. Thus it happens that in so many instances the expedient of an outline is preferable. It enables one deliberately and safely to adopt a scheme of color which, but for it, would be altogether ineffective.

I am not insisting upon the use of outline, but showing of what use it may be. Don't, by any means, accept the dogma of its saving merit, and don't let it tyrannize over you. Art may quite well be decorative in which the outline is not emphasized, nor does the insistence upon it make design decorative, however effectually it may remove it from the pictorial.

It is time I came back to the reasons for conventional treatment in design. The most urgent of them remain yet to be considered, viz., the nature of the material, the character of the tools, and the process of execution employed.

In discussing the anatomy of pattern, I pointed out how its construction was affected by, and very often directly due to, some particular manufacture or method of work. So it is with the details of ornamental design. The exquisite simplicity of certain characteristic patterns familiar in the figured velvets of the fifteenth century is cleverly calculated to disturb the least possible amount of the sumptuous pile, so that the full value of the rich texture is preserved. Again, in the Renaissance damask patterns, those big leaves and scrolls are devised with a view, before all things, of getting a broken effect of color. The designer relied upon the quality of the silk, with its varying sheen, to alleviate the exceeding flatness of the pattern. In a multitude of smaller parts, the admirable repose and breadth of the design would have been lost, as well as something of the quality of the stuff. Our manufacturers desire equally to exhibit the quality of their material, but they can think of no other way of doing it than by leaving it empty. Perhaps they have the lady purchaser in view. Any way, they appear to have a rooted belief in the suitability or salability of the *petite*.

By the way, it should be pointed out that in certain other woven fabrics of our time the hope of disguising the shabbiness of the material has led to adoption of the fussiest kinds of patterns. One should beware of textiles worried all over with pattern—in many cases it is done to hide shoddy. The manufacturer of *bona fide* silk, or wool, or other worthy material, would do well to identify his goods with a kind of design which the baser fabrics cannot imitate without convicting themselves.

The character of the Lyons silk designs of the seventeenth and eighteenth centuries owes very much, I take it, to the circumstance that the lustrous material was so fascinating that the artists were led astray from beautiful form, and simply reveled in the delights of color. Charming as these silks often are, translate any one of the patterns into uncompromising black and white, and you are disillusioned at once.

In these later figured silks, as well as in the earlier damasks, the pattern was usually designed without much regard to the joining of the breadth. The designer doubtless reckoned that the material would be used for curtains, to fall in full folds; for furniture, in which a single breadth only would be used; or as a dress fabric, in which the pattern would never by any chance be seen in its entirety at all. To this day silks and velvets are designed in France so that the pattern groups itself into two unequal bouquets, the one intended for the back of a chair, the other for the seat.

The style peculiar to each particular kind of work is, indeed, so strongly marked, that it would be quite feasible to classify ornament according to its evolution. "Style," said Mr. Worrum, "is analogous to hand in writing," and not a tool or process but has written its character upon the work it has done. It was so even in so simple a matter as lettering. The cuneiform character of the ancient Assyrian inscriptions was developed chisel in hand, as you may see in Fig. 17. In the same diagram you will perceive how Chinese or Japanese writing could only have been shaped by the brush, and again, in the example of very early Greek character, the influence of the stylus seems to betray itself.

The simple forms of the Roman letters A B C, etc., in Fig. 18, might equally have been indented on a soft substance with a point. The later form of lettering, shown in D E F, with its thick and thin lines and its spurred ends, was better calculated for incising or engraving. Or it might have been due to the use of the pen, as the Gothic form of the letter, exemplified in G, undoubtedly was. Again, the smaller Roman letters, h, i, j, are unmistakably related to the "round hand" k, l, m. But it is in the medieval "black letter" that the penmanship is most plainly pronounced, as in the letters n, o, p, q, r, s, t, or in the capital U, or the yet more fantastically flourishing W.

In our own day we are given to the cultivation of "a good business hand," which is just a little characterless and monotonous, as are indeed the lives of some of those who accomplish that modest end. There was when the pen of the ready writer indulged in occasional flourishes. There is no time for such frivolity nowadays, and what little character there is left in our hand is likely to be sacrificed to the convenience of the stylographic pen, even if we do not give up penmanship altogether in favor of what is called "the literary machine."

Style, then, as I understand it, is not so much a thing of dates and countries as of materials and tools. Whenever the development of ornament is discussed, it is the custom to begin with the savage. How the aboriginal developed into the Assyrian is not very clearly shown. But from Assyrian art is traced Egyptian art, and from that again Greek art, and its Roman imitation, all very plausibly. The foundations of Byzantine art upon the ruins of classic, the growth of Gothic, the reaction of the Renaissance, its transplanting and its degradation, follow in accustomed order. It is easier to jog along this well beaten and rather tedious road than to explain how, all the while parallel with this, Oriental art was pursuing a course of its own, impinging, nevertheless, at times upon Western art, and whenever that was the case, leaving the imprint of its influence upon it. This would be well worth doing, but it would take a long series of lectures to do it in, and would demand, besides, historical knowledge far

greater than I can pretend to—a knowledge perhaps scarcely compatible with the necessary knowledge of art.

Still more to the purpose would it be to classify ornament according as it was plaited, notched, scratched, turned, modeled, carved, painted, inlaid, printed, woven, embroidered, or what not. Architecture would divide itself into masonry, brick, concrete, timber, and plaster styles. The subsidiary arts would class themselves according to the use of clay, stone, wood, metal, yarn, and so on, in them; and there would be further subdivisions into granite, marble, sandstone; into hard and soft wood, close grained and variegated; into wrought, cast, chased, or beaten metal; into tapestry, cloth, damask, velvet, brocade, embroidery, lace, and so on.

What are known as the historic styles might be examined by the way. They would go to illustrate the development of style more technically considered. In all probability it would be shown that wherever the historic style is marked, its character is to be traced to some mode of workmanship which, if it did not actually inspire it, made it advisable. The characteristic ornamental forms of a period or people can usually be traced to the technique and needs of that same people. Thus far, ornament rises to the dignity of history.

Such a classification as I have sketched would lead us very far afield. It is possible, however, to give shortly some illustrations of what is meant. Compare for a moment the sculpture of Egypt, of Greece, and of mediæval Europe. The styles are not more distinctly Egyptian, Greek, and Gothic, than they are markedly granite, marble, and soft stone styles. The monumental simplicity of the obelisk, the refinement of the Pheidias temple, the rude grandeur of the Gothic minster, were but the natural development of the resources near at hand.

Working in porphyry, basalt, or granite, severe simplicity was inevitable, and the Egyptian was severe with a vengeance. There was no temptation to him to fritter away all breadth in the accumulation of detail. On the other hand, the more even textured and less obstinate marble encouraged the Greek sculptor to greater and ever greater delicacy and subtlety of

The conventional treatment of foliated forms (of which I shall have more to say in my next lecture), in all countries and in all times, until a comparatively recent date, has borne the impress of its execution. The so-called honeysuckle of the Greeks I have shown elsewhere* to be directly traceable to the use of the brush, as was the case with other familiar forms of painted Greek ornament. The Corinthian capital, on the other hand, and the acanthus scroll, even when they most nearly approach nature (which is never very closely), are always modified according to the conditions of sculpture.

In the Byzantine version of the classic leafage, in which the sculptors made abundant use of the drill, the drill holes form an element in the design. The characteristic turn about it is the turn of the drill.

The somewhat savage enrichment of our own Norman buildings reminds one forcibly of the rude way in which it was done. It is chopped rather than carved. And in the Gothic rendering of foliated forms, whether carved in stone or wood, or painted on wall or window, or wrought in metal, there is always a touch of the tool which removes it by so much, I will not say from nature, because the instinct which directs all such modification is natural enough, but from the imitation of nature.

To refer to a specific material, you cannot look at the ironwork of any early period without seeing how directly the forge has influenced its design. The Italian scroll is more graceful than the English, the German more fantastic and elaborate. The work of Augsburg is not even just that of Nuremberg. But with all its variety it is everywhere characteristic of the smith. Even when it breaks out, as it did in the seventeenth century, when art knew no restraint, into an uncomfortably bristling form of foliage, it breathes always the atmosphere of the forge. Nature inspired, the hammer and the pincers shaped it.

It is precisely for this reason that our modern casting of wrought forms is so singularly ill judged. There is nothing contemptible in cast iron if we would but abstain from the reproduction in it of forms altogether inappropriate to casting. We should have no cause to regret that the day of the foundry has come, if founders would but put some real art into their moulds; and the first step toward that end would be to forget, if they can, the familiar forms of the forge. People talk about cast iron as if it were an abomination; and so it often is; but there is no reason but our incompetence why we should not do in iron in the nineteenth century what the Italians did in bronze in the fifteenth.

It is not to be supposed that any one but a workman will ordinarily know enough of technique fully to appreciate the influence of tool and treatment upon ornamental design, still less to trace the origin of ornamental forms to their first cause; but it is none the less true that most, if not all, ornament may be followed back to such a source.

Take any tool in hand and proceed to design with it, and see what comes of the experiment. It will be something quite different from what you would have drawn with a pencil on paper, and something much less literally like anything natural.

You know how embossing or *repoussé* work is done. You take a sheet of thin metal, say copper, and lay it with its polished surface downward on a bed or cushion of pitch, and proceed with tools of various shapes and sizes to punch up the pattern from the back. Now, if you have any feeling for the material at all (and if you have not, you have mistaken your vocation), you begin very naturally to do what can be done in it. Accordingly you set to work to beat out certain round bosses, which you surround with smaller bosses, arriving so at something like flowers. These you go on to connect with rounded stems, from which grows a kind of foliage, large or small in detail as need may be, but always more or less bulbous in shape. You arrive thus at a pattern which is characteristically *repoussé*, beaten work, and which has grown to a great extent out of the conditions under which you were working. And it cannot be insisted upon too strongly that in designing for ornament, it is absolutely essential always to have those conditions in mind, as clearly as though you were yourself working under them.

In beaten work you descend from the mass to the minutie. In filigree, on the contrary, you would work from the minutie to the mass. Commencing with wiry lines, you would perhaps clothe them with more compact spirals, clustering these together where you wished to concentrate the effect. This is the type of all ornament in delicately elaborate line, as, for instance, niello or damascening, or embroidery in gold or silver outline, or, on a larger scale, hammered ironwork. Substituting straight lines for curved, it has its parallel in certain kinds of lacework, and in some of the book-binders' "tooling" of the sixteenth century, which is indeed founded upon lace, but which has, nevertheless, a character of its own.

To take a last homely instance. Suppose you were designing for fret work. The very idea of fret cutting would suggest a kind of pattern familiar enough. Either you would devise a form of pierced ornament, having all the character of stenciled work (the stencil is, in point of fact, a paper fret, through which you dab on the paint), or, if you preferred to cut away the ground instead of the pattern, you would be bound to hold the design together by ties. These would sadly mar the effect of your pattern, unless from the first you took them into consideration, which you would instinctively do; and the result of it would probably be some sort of strap work, such as that which is so infallible a feature in Elizabethan wood carving, which very possibly owed its origin in part to some such device, though its more evident source is in the forms peculiar to metal work.

The stencil patterns in Fig. 20 explain themselves pretty well. The yare designed to be stenciled right off, without any need of making good afterward.

In the case of the radiating pattern the ties themselves are made use of to form a pattern on the pattern; so many conventional veins to equally conventional leaves.

The characterlessness of nineteenth century ornament is due very largely to the absence of any impress of the tool upon design. In the process of modern manufacture, everything is planed down to a marvelous, but monotonous, smoothness. The mark of the tool, which

is the evidence of workmanliness, is popularly regarded even as bad work—want of finish, indeed. There are some, in this enlightened age of ours, who need to be reminded that the smoothly smug is not the beautiful, nor even the finished. Not that the fallacy is altogether a modern one. Tapestry designers for centuries past have been working steadily in the pictorial direction, and against the threads, until there is now little difference between the picture and its copy in wool, except that the latter costs ever so much more than the original. Even in the comparatively early tapestries of Raffaele you can see at Dresden or Beauvais what inferior and characterless hangings his famous cartoons make, as compared with the designs of earlier, unknown, and less accomplished draughtsmen, who knew their trade. Raffaele either knew little or cared little about tapestry, that is clear, and in his failure there is some consolation for the least of us. If we only love our trade and know it, as only those can who love it, we may succeed where a Raffaele would fail, though we may be anything but Raffaeles.

The crowning point of inconsistency is achieved where it is not nature that is copied, but some convention peculiar to, and characteristic of, a quite different material or treatment—as when the bulbous character of beaten metal, or the facets of monstrous jewels, are imitated in wood carving, or when the broken lines which occur inevitably in coarse carpet weaving or Berlin wool work are copied in wall paper.

Equally absurd is the application to any purpose of a process altogether out of keeping with it. I remember seeing in Paris some years ago (1882) a chimney piece built on the massive lines of the Francois premier period, but executed in wood instead of stone, and completely covered, mouldings and all, in cloth embroidered in the place of sculpture, and fitting as faultlessly as though a first class tailor had done it. And only the other day I noticed, in a London shop window, an easel covered in crimson plush, draped with a scarf of the same, presumably as an ornament for the drawing room. It is only natural to try and turn one's trade to the utmost possible use, partly out of workmanlike pride, and partly out of considerations less conspicuously praiseworthy; but this kind of thing is a *reductio ad absurdum*, which in the end must discredit a calling. There is never an exhibition but we are warned by ill-judged exhibits, over and over again, against the theory that there's "nothing like leather."

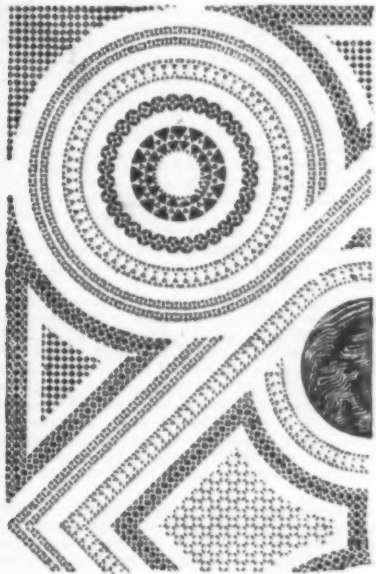


FIG. 19.

execution, which, again, would have been altogether out of the question in carving the more friable stone employed in our own country. In like manner the richer scheme of architectural coloring which prevailed in Italy was encouraged, if not altogether suggested, by the gorgeously of the multicolored marbles within easy reach, which marble led also to the development of a kind of decoration very characteristically mosaic, in which the beauty of the material is displayed in large slabs of rich veneer, while the waste is used up in the form of geometric pattern work, the design of which is literally cut according to the chips. Fig. 19 shows somewhat the kind of thing alluded to, but it gives only imperfectly a very common feature in the Italian pavement patterns, which is a big circular plaque of porphyry, or what not, recurring at intervals in the design. This was in all probability only a device for turning to account the odd columns remaining from ancient buildings. The plaques are, in fact, so many slices of old columns, but what admirable ornamental use has been made of them!

The adoption of geometric patterns for inlaid pavements was countenanced by the circumstance that the unequal and accidental color of the marble cubes just counteracted the tendency to mechanical hardness, in which lies the danger of purely geometric ornament.

So in the ornamental glass mosaic so often used in Italy in Giotto's time in connection with white marble, the shimmer of the surface, more especially as it was never absolutely even, put all contingency of harshness out of the question. Such a thing was not possible with all these little facets of glass catching the light at all manner of angles, and glittering each according to its own bright will.

In wood inlay, or marquetry, similar geometric forms were found, for similar reasons, to be eminently serviceable, so that one may say that, whether in wood, or glass, or marble, a style of inlaid pattern work was begotten of the very facility of shaping and laying geometric forms by the certainty of the harmonizing influence of color.

It is in the inlay of natural woods and stones and the like that we find the most satisfactory use of absolutely geometric pattern. The accidental variation of the natural colors is exactly the thing needful. The unexpectedness of the tints makes amends for the certainty of the shapes, and gives an air of mystery to what would otherwise be only so much mechanism.



FIG. 20.

Why can't we be content to do what we can do, and do best?

Assuming, on the one hand, the urgency for some modification of natural forms according to the work in hand, and on the other of some continual reference to nature in design, the question arises as to the limits of the one and of the other. How far may one safely go in the direction of nature? And to what extent is it well to admit the dictation of the tool? In order to settle that point quite definitely, each separate craft would have to be discussed. An excellent prescription would be just so much of natural food as the artistic stomach can digest; but then we have to reckon on a person's powers of artistic assimilation—always an unknown quantity.

The conclusion I have arrived at is this, that the convenient stopping point is the point at which a material or process fails, the point, in fact, at which one is tempted to bring in some supplementary process: which process, under pretense of helping it, ends eventually, more or less, in effacing it. I don't mean to say that two or more processes may not be associated, but there should be very good reason shown for their association.

In all applied art, and in every stage of it, the work in hand points out, if you will only listen to it, the degree and kind of conventionality that is called for. I lay down no law but this: Consider the nature of the materials and tools you are using, and the place and purpose of your work. So much convention as they suggest is needed, and no more.

THE AMERICAN EXHIBITION.

THE long talked of American Exhibition will be opened in May next, and will offer during the coming summer, to Londoners and provincial and foreign visitors, an attraction full of interest and novelty. It is only just to an undertaking that has been developed to a practical issue under circumstances of peculiar difficulty, to explain in a few words the causes that have led to its postponement from the last to the present year, a delay that tended in some degree to promote a belief that the undertaking would be abandoned. The proposal of an exhibition confined exclusively to United States productions was due to an American, who did little, however, and retired from the scheme before it had made much progress. The whole re-

* "Everyday Art," p. 106.

responsibility thereafter fell on Mr. John R. Whitley, to whom the whole credit of the exhibition, and whatever success it may achieve, will be due. As may be readily imagined, the labor of awakening the interest of Americans of position and means to engage in the undertaking, and to guarantee funds, not with any speculative object, but on the wide grounds of benefiting American trade, was no light one. This difficulty, however, Mr. Whitley has triumphantly overcome, and few exhibitions have ever had a more responsible list of guarantors. The work of inducing American manufacturers to send specimens of their products to this country for exhibition was considerable, but this difficulty has also disappeared, so completely that the ample floor area of the exhibition building will not meet the demand for space. But all these onerous preparations involved much loss of time, as well as untiring energy, and when the first days of January, 1886, arrived, it became clear that if the exhibition was to be opened the following May, promoters and exhibitors alike must be hurried beyond reasonable limits. Still, had it not been for another powerful reason, the American Exhibition would by this time have come and gone. The last great effort at South Kensington, the Indian and Colonial Exhibition, which concluded the series of four annual shows, was to be held. It was to be far in advance of its predecessors in completeness and imperial attractions, and it was very rightly judged that before such a rival the charms of the American Exhibition would suffer partial eclipse.

The masses, however insatiable, would hesitate at

(and how contrary things connected with exhibitions will go, only those who have taken part in their preliminaries can tell), the greater efforts must be made to put them straight.

The main building (we can speak of it in the present tense now) is 1,140 ft. long by 120 ft. wide. The roof will consist of galvanized iron, with plenty of glass, so as to give ample light. The framework is composed of, as said above, railway rails, the columns, formed by two rails fastened together, being footed in iron castings sunk well in the ground and supported on concrete foundations. The flooring will be of wood. Although the corrugated iron is not yet fixed, enough has been done to give an idea of the imposing vista that will be formed by 1,140 ft. of the building. The floor area will be divided longitudinally by four avenues, Washington, Franklin, Lincoln, and Cleveland, and at right angles to these will be a number of "streets," running from "1st" to "10th."

The grand entrance will be from Lillie road, and a substantial vestibule of brick has already been constructed. The design is in good taste, not too ornate, but sufficiently imposing for the purpose. The executive offices at the side work harmoniously into the plan.

Although the main entrance is officially in the Lillie road, we think that by far the largest number of visitors will pass into the exhibition from the Earl's Court station, where extensive preparations are being made to accommodate the throng of sightseers that will surely flock to the American Exhibition during the coming summer. There are, it should be added, special

At the north end of the main building the machinery in motion will be placed. We anticipate that this will form a very attractive part of the show, but we will not anticipate the interest that it will excite by any premature and imperfect descriptions. For the present it will be sufficient to state that the chief motor will be a 300 horse power Wheelock engine, supplied with steam by a battery of Babcock & Wilcox boilers, placed in a separate building, as shown in the plan. Messrs. Hornaby & Son, of Grantham, are providing 600 horsepower for the electric lighting, which will be mainly on the Houston-Thomson system.

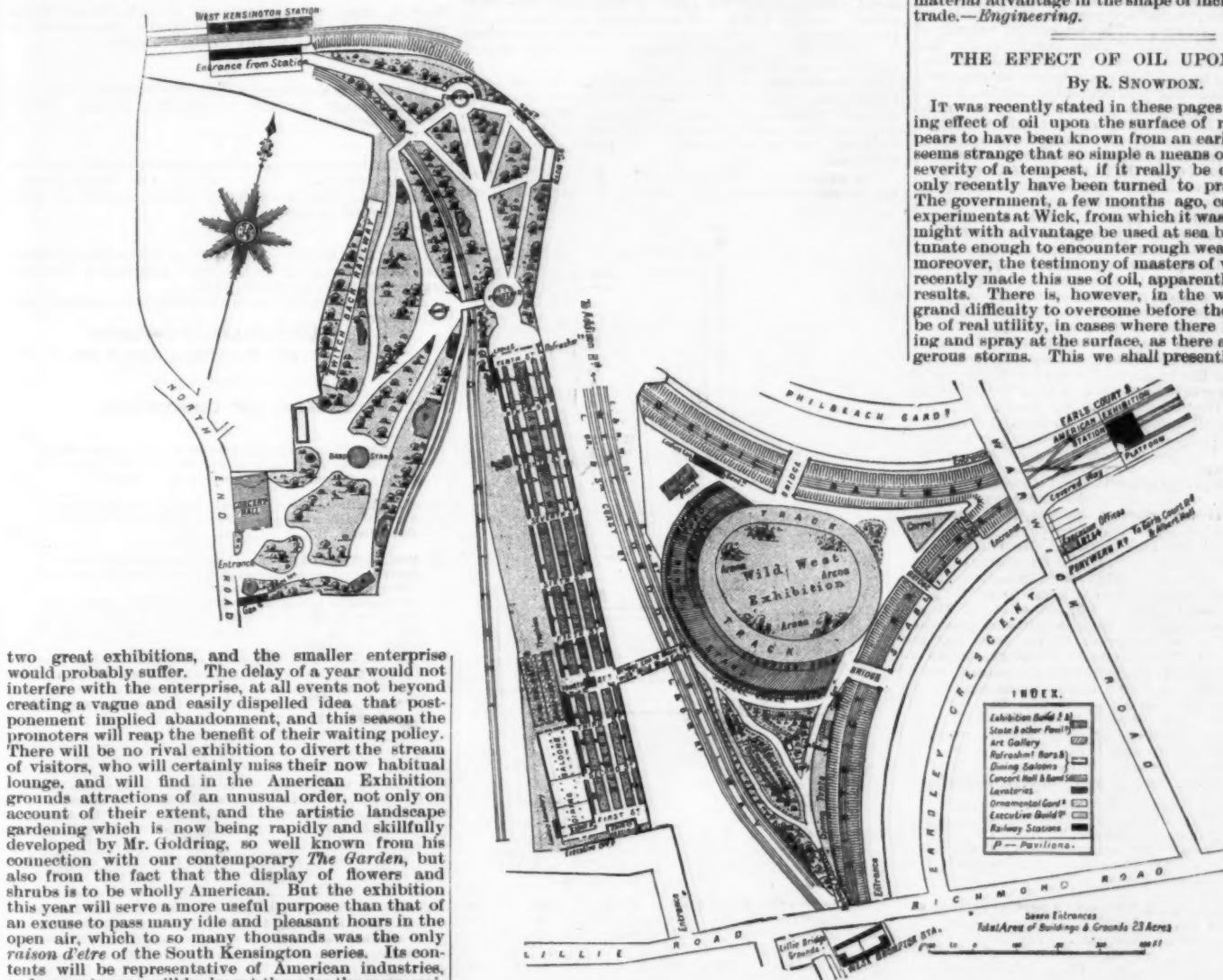
In our note recently we mentioned the "Wild West" exhibit, and a reference to the plan we now publish will give some idea of the magnitude of the grand stand that is now all but complete. It is a timber structure, and we may add, for the peace of mind of the crowd of visitors that will throng its slopes, that the details of construction have been approved by the board of trade. Indeed, the whole of the buildings and erections that are to be accessible to the public have, we understand, passed the necessary ordeal of government inspection.

As to the great body of the exhibits, which will form the serious attraction of the whole enterprise, it is as yet too early to say anything. From what we have heard, however, at one time and another, we have little doubt but that the high opinion we in England have of American enterprise and ingenuity will by no means be lessened by the great exhibition the United States are sending to London for our amusement and instruction—without forgetting, perhaps, their own material advantage in the shape of increased European trade.—*Engineering.*

THE EFFECT OF OIL UPON WAVES.

By R. SNOWDON.

It was recently stated in these pages that the damping effect of oil upon the surface of rough water appears to have been known from an early period, and it seems strange that so simple a means of controlling the severity of a tempest, if it really be effectual, should only recently have been turned to practical account. The government, a few months ago, carried out some experiments at Wick, from which it was inferred that oil might with advantage be used at sea by vessels unfortunate enough to encounter rough weather. There is, moreover, the testimony of masters of vessels who have recently made this use of oil, apparently with the best results. There is, however, in the writer's view, one grand difficulty to overcome before the expedient can be of real utility, in cases where there is much splashing and spray at the surface, as there always is in dangerous storms. This we shall presently explain. The



PLAN OF THE AMERICAN EXHIBITION, LONDON.

two great exhibitions, and the smaller enterprise would probably suffer. The delay of a year would not interfere with the enterprise, at all events not beyond creating a vague and easily dispelled idea that postponement implied abandonment, and this season the promoters will reap the benefit of their waiting policy. There will be no rival exhibition to divert the stream of visitors, who will certainly miss their now habitual lounge, and will find in the American Exhibition grounds attractions of an unusual order, not only on account of their extent, and the artistic landscape gardening which is now being rapidly and skillfully developed by Mr. Goldring, so well known from his connection with our contemporary *The Garden*, but also from the fact that the display of flowers and shrubs is to be wholly American. But the exhibition this year will serve a more useful purpose than that of an excuse to pass many idle and pleasant hours in the open air, which to so many thousands was the only *raison d'être* of the South Kensington series. Its contents will be representative of American industries, and many lessons will be learnt there by the more serious visitors, who will have a better opportunity than they could otherwise have enjoyed of gauging the strength and weakness of our most dangerous trade competitors at home and abroad. Of the design of the exhibition building there is little to be said, except that it provides a large, well lighted area for exhibits and visitors. The plan is due to Mr. D'Orsay, who has made the best of the bad idea to press material intended for one purpose into the service of another. The framework is constructed mainly of rails, and rails will not lend themselves fittingly or harmoniously to form columns, or be converted into roof trusses. This, however, is a comparatively small matter, and when completed, the construction of the building will challenge but little criticism from visitors, whose attention will be turned to the consideration of its contents.

Above will be found a plan of the whole exhibition, including the main building and the grounds. Doubtless, however, there will be many additions in the shape of supplemental buildings to accommodate special exhibits, and, indeed, arrangements have already been made for various accessions of this kind. For instance, there will be the house of straw, about which we shall have more to say in the fullness of time.

The main building, it will be seen, is in the center, being flanked on one side, the east it happens, by the "Wild West," and on the west by the grounds which Mr. Goldring was so rapidly converting into a foreign garden until the unseasonable return of winter, with the heavy snow storm of March 5, did so much to check the work. Indeed, the last snow storm must have proved a most serious hindrance to progress, but efforts have not been slackened, for the policy of the executive seems to be, that the more things go contrary

entrances both from the West Brompton and West Kensington stations, so that the exhibition can be entered direct from three important stations.

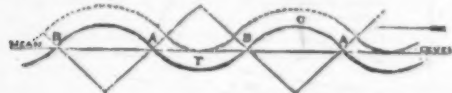
The principal dining saloon, it will be seen, is near the main entrance. It is 240 ft. long by 90 ft. wide. We are not aware what arrangements have been made with regard to this most important point of exhibition management. The "refreshment department" is generally the pitfall of the executive of such shows, and we trust in this instance the public will not be handed over to the untender mercies of those gigantic purveyors of expensive dyspepsia sometimes known as refreshment contractors, to be ill-fed and overcharged without remedy or redress. It would of course be in accordance with the scheme of the exhibition that an American *cuisine* should be provided. But though American fare is excellent, this is due more to the bounty of nature than the efforts of art. Still a good American dinner, with all its bounteous variety, would be a revelation to many, and certainly prove a great attraction. We trust our readers will pardon this passing allusion to a very commonplace subject, but we speak feelingly in memory of the experience of past years.

Adjoining the dining saloon is the fine art gallery, where will be hung very large and representative loan collections of the works of American artists, by far the most complete that has ever been assembled. The building is to be 160 ft. long by 80 ft. wide. It is to be of fireproof construction and divided into eight rooms. The exhibits will be wholly national.

most effectual method hitherto devised of using the oil is to tow a bag full of cotton waste or other fibrous material, previously saturated with the oil, from the vessel's yard arm on the weather side. The advantage of this method of use over that of pouring the oil directly on to the surface appears to be owing to the tendency of the greater part of the oil, when thrown into the water, to assume the form of globules—bubbles of oil, so to speak, being produced, which float in a similar manner to aerial bubbles, but burst far less readily. They do, however, burst eventually, and spread into a film, unless there be much splashing at the surface, in which case they may not burst at all, but become subdivided into smaller and smaller globules, approaching the character of an emulsion. Large globules of the same oil burst more readily than smaller ones; globules of the same size, but of different oils, burst the more readily the lower their specific gravity. But, worst of all, if a surface covered with a perfect oil film be strongly agitated in imitation of surf, even the film seems to be gathered into minute globules and emulsified. In the writer's view, it is in the trouble of getting an extensive film to form over a very rough broken surface that the one grand difficulty lies. A single drop of castor oil allowed to fall lightly upon the surface of tolerably smooth water flashes out in a few seconds into an exceedingly thin film, which shows the prismatic colors, and about a foot in area. As the oil spreads, any light floating material is pushed aside by it, apparently with a force one would hardly look for in a thin film. Let us suppose that we have surmounted

every difficulty, and obtained a more or less perfect film of oil. How does such a film produce a damping effect upon troubled surfaces? Of course, the present theory is that it diminishes the friction of the wind against the surface, by which the waves are produced. But how can a frictional force, necessarily acting parallel to the surface at all points, possibly raise a wave? Probably much more use would be made of oil in storms if it were easier to see that an oil film, provided it can only be produced, must exercise a quieting effect upon the waves. Even in the experiments at Wick referred to, the good effect of the oil was merely inferred; it was impossible to obtain any absolute proof whether any effect was due to it or not. In order to settle this question, it must be observed that the film of oil which we suppose to cover the surface tends strongly to preserve equality of thickness in itself, and that it exerts a moderate degree of friction against the surface upon which it rests, whenever that surface moves in relation to it. Its effect may, therefore, be compared very aptly with that of a thin sheet of elastic material—India rubber, for instance—spread over the surface of the water.

If we now analyze the motion which takes place in a liquid surface in which ordinary waves are moving, we find that each particle at the surface moves in a nearly elliptical path, which lies in a vertical plane at right angles to the direction of the waves' progression. Thus, at any given moment, the particles at the crests and those at the troughs are moving tangentially to the curve, that is, horizontally, and in opposite directions to each other, with maximum velocity, those of the crests rushing forward in the direction of propagation, while those at the troughs are rushing backward with nearly the same velocity. The tangential velocity of the particles on either side of these points, in the line of propagation, is less the nearer they are to the lines midway between trough and crest, being momentarily nil at these points. But this tangential motion is compounded with a lesser motion, which takes place in the direction normal to the wave surface, and which increases from zero at crest and trough to maximum value at the neutral line. Hence the particles on either side of the neutral line on the front side of each billow are rushing together and swelling up the surface there by their momentum, while on the rear side they are rushing apart with an opposite momentum, and depressing the surface so as to propagate the undulation, which in its progress brings all surface particles in the line of disturbance successively into these relations. Since, therefore, one-half of the surface of every wave is moving in an opposite direction to the other half, it should be easy to see that a tenuous film, resting upon the surface, and exerting friction against it, must needs resist the alternating currents essential to the wave undulations, and therefore, in a corresponding degree, resist the force of the tempest. We may in a few words examine the cause of waves at sea, with a view to dispel the notion that friction has anything to do with their production. Small initial disturbances of the equanimity of the sea's surface may be produced in a multitude of ways. For the sake of a beginning, we will suppose that a gust of wind sweeps over the surface. A gust is accompanied by a slight local variation of barometric pressure. That part of the surface upon which the pressure is temporarily increased is slightly depressed; that where the pressure is lowered rises a little. After the cause of disturbance has gone, the surface seeks to regain its normal level, and a number of oscillations take place, just as when a stone is thrown into a pool, so as to give off a series of waves, the amplitude and length of which will depend fundamentally upon depth and area disturbed. Water is no exception to the rule that all things capable of transmitting vibratory or wave motion have a certain fundamental or natural wave period of their own, in which a very small amount of energy suffices to set up and maintain the state of vibration. As the gale sweeps over these initial corrugations, the current of air next the surface must be alternately deflected up and down (see figure) so as to follow its sinuous curvature. Thus in passing from A to B over the convex crest of each wave, a centrifugal



force is developed, which produces a partial vacuum on the inside of the curve, thereby tending to raise the water up still higher in this part. [The arrow shows the direction of wind and wave motion.] Conversely, in sweeping over the concave surface B to A, a centrifugal force is again developed, which produces a pressure on the outside of the curve, that is, upon the surface of the water in the trough, tending to still further depress this part of the surface. In this way, as the wave progresses, it gathers force, its amplitude or its length, or both, increasing until finally, if the gale be strong enough, it breaks. This has been partly demonstrated by directing a blast from a fan horizontally over the upper surface of a corrugated sheet, in which a crest, C, and a trough, T, were cut out and balanced upon a weighing machine underneath. The crest was found to rise and the trough to descend as the current swept over them, and with a force nearly proportional to the square of its velocity.

The wave-producing power of the wind may, therefore, be said to vary nearly as the square of the difference between the wind and wave velocities. By allowing the current to sweep over the lower as well as upper surface of the corrugations, the force was doubled. The direction given to the waves produced by the wind is the same as that of the wind itself. The reason of this appears to be that the vacuum on the front side of a wave crest is rather greater than that on the rear side, while the pressure upon the front half of each trough is greater than that on the rear half. This was also demonstrated by means of a weighing machine. It follows, from what has been explained in the beginning of this article, that the best oil for use in a rough sea is that which, other things being equal, has the lowest specific gravity, that is, which exhibits the least tendency to assume or to remain in the spheroidal condition and which spreads over the surface at the greatest rate, for only when an extensive surface on the weather bearing of a vessel's course has been put under the film need a tangible result be expected. As to the mode of ap-

plying the oil, a large wick, fed in lamp fashion from a barrel or tank, fixed above the water level, and passing over the side of the vessel into the water, would serve more effectually than any plan hitherto tried.

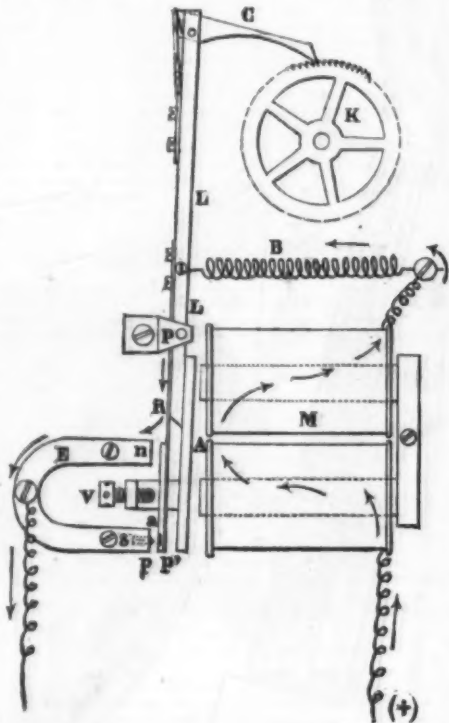
If the vessel be running before the gale, the whole of the oil film will lie astern of her, and the fullest advantage would therefore be reaped, and in this case also it might be a good plan to throw overboard at intervals small bags of waste saturated with oil, which would be left behind, and renew the film as it was destroyed by the surf, until the oil became exhausted. These suggestions are made for what they may be worth; certainly, if a suitable oil and efficient means of using it can be found, it ought to prove an incalculable boon to those who are forced by fate to hazard their lives or their property upon the great deep.—*Industries.*

NEW APPARATUS FOR CONVERTING ELECTRIC ENERGY INTO MECHANICAL WORK.

The electric devices known as vibrating mechanisms consist, as well known, of an electro magnet and its armature, the latter being so arranged as to break the current of the electro as soon as it is attracted thereby, and to be drawn back by a spring when the attraction ceases, and so on. As the succession of these alternating motions is very rapid, it causes a strong vibration of the armatures; but it is attended with two drawbacks, viz.: 1. The duration of the successive interruptions is sensibly equal to that of the closings of the current, and all are extremely short; whence there results a great consumption of current, and consequently a rapid polarization of the piles. 2. Such great vibratory velocity as this is not well calculated to permit of the vibrating mechanism being applied for the conversion of electric energy into mechanical work, as in electric clocks, for example.

Mr. Kornmuller, of Gand (Belgium), has devised an arrangement designed to overcome these two inconveniences by rendering the periods of interruption lengthy, while at the same time they continue to have their contacts, and consequently their rapid and short attractions.

The apparatus, which is shown in the accompanying figure, consists of an electro magnet, M, whose armature,



A, is fixed to the upper part of a lever, L, that oscillates around a pivot, P. At its upper part, the lever is provided with a click, C, which, through a spring, is made to bear against the teeth of a ratchet wheel, K. Another spring, R, which likewise is fixed to the lever, L, is provided at its free extremity with an armature, a. This latter faces a small permanent horseshoe magnet, E, with poles, n s. To the pole, s, is fixed a small platinum contact, p, which corresponds to a small platinum plate, p', set into the armature, a. Finally to the armature, A, is fixed a sort of bridge provided with a regulating screw, V. A spiral spring, B, serves to pull the armature back as soon as it is no longer attracted by the electro

The arrows show the route of the current through the apparatus.

It will now be understood that when the contact p p' is closed, the current coming from the positive pole will follow the route, M B L R a p p E, and return to the negative pole. The circuit will then be closed, and the electro, M, will attract its armature, A, which will oscillate at P, and separate slightly from the flexible spring, R, whose armature, a, remains attracted by the permanent magnet, E. There is thus produced a slight prolongation of the attraction, whose duration may be limited at will by regulating the screw, V, which, carried along by the armature, A, breaks the circuit by detaching the armature, a.

When under the action of the spring, R, the armature, A, separates from the electro magnet, and the armature, a, nearly reaches the permanent magnet, E, the last named armature suddenly separates from A, and operates the contact, p p', shortly before the click, C, has reached the end of its travel. The attractive action of the electro magnet, M, breaks the inertia of the lever, L, and of the armature, A, which both come to a standstill without the production of any shock to interfere with the regularity of the apparatus.

It will be well understood, then, that this arrangement effects the conversion of electric energy into me-

chanical work perfectly, by means of an electro magnet acting upon an armature in such a way that the separation of the latter from it shall be slow and regular, while its attraction is sudden and rapid.

The applications of apparatus of this kind are already numerous. They are particularly well adapted for actuating electric clocks.

Experiments have shown that two elements of a constant system (Daniell, Meidinger, etc.) suffice to actuate a clock for fifteen consecutive months without any necessity of touching the battery. When several clocks are placed upon the same circuit, it will suffice to have but one of them provided with the arrangement in question, the rest being actuated by an electro magnet provided with any sort of device for producing a back motion.—*Chronique Industrielle.*

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